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(71) Applicant: GENTEX CORPORATION [US/US]; 600 North Centennial Street, Zeeland, MI 49464 (US).

(72) Inventors: CAMMENGA, David, J.; 221 Riverbend Court, Zeeland, MI 49464 (US). TONAR, William, L.; 40 Cheyenne, Holland, MI 49424 (US). VANDER ZWAAG, Scott, W.; 536 West 48th Street, Holland, MI 49423 (US). ROBERTS, John, K.; 1061 Plymouth Avenue, S.E., East Grand Rapids, MI 49506 (US). BAUER, Frederick, T.; 236 Dykan Avenue, Holland, MI 49424 (US). FORGETTE, Jeffrey, A.; 8593 Willowrun Drive, Jenison, MI 49428 (US). ANDERSON, John, S.; 108 East 21st Street, Holland, MI 49423 (US). BECHTEL, Jon, H.; 136 Sunrise Drive, Holland, MI 49423 (US). CARTER, John, W.; 2278 Woodlark Drive, Holland, MI (US). STAM, Joseph, S.; 345 South Lakeshore Drive, Holland, MI 49424 (US).

(74) Agent: CARRIER, Robert, J.; 695 Kenmoor, S.E., P.O. Box 2567, Grand Rapids, MI 49501 (US).

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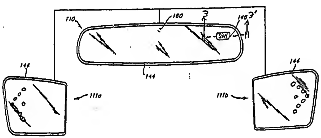

(57) Abstract

An electrochromic mirror is disclosed for use in a vehicle rearview mirror assembly (110) having an electronic device (160, 170, 220, 725) positioned behind the electrochromic mirror for selectively projecting and/or receiving light through the mirror. The electrochromic mirror includes an electrode (120) that includes a layer of reflective material (121) and a coating of electrically conductive material (172) that is at least partially transmissive. The second electrode further includes a region (146) in front of the electronic device that is least partially transmissive. The electrically conductive coating may include a single transparent layer or a plurality of partially reflective and transmissive layers, or an electrically conductive dichroic coating. The elecrronic device may be a light sensor (160) or a light source such as an information display (170) or a signal light (220).

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ELECTROCHROMIC MIRROR INCORPORATING A THIRD SURFACE RELFECTOR

BACKGROUND OF THE INVENTION

This invention relates to electrochromic rearview mirrors for motor vehicles and, more particularly, to improved electrochromic rearview mirrors incorporating a third surface reflector/electrode in contact with at least one solution-phase electrochromic material.

Heretofore, various rearview mirrors for motor vehicles have been proposed which change from the full reflectance mode (day) to the partial reflectance mode(s) (night) for glare-protection purposes from light emanating from the headlights of vehicles approaching from the rear. Among such devices are those wherein the transmittance is varied by thermochromic, photochromic, or electro-optic means (*e.g.*, liquid crystal, dipolar suspension, electrophoretic, electrochromic, etc.) and where the variable transmittance characteristic affects electromagnetic radiation that is at least partly in the visible spectrum (wavelengths from about 3800 Å to about 7800 Å). Devices of reversibly variable transmittance to electromagnetic radiation have been proposed as the variable transmittance element in variable transmittance light-filters, variable reflectance mirrors, and display devices, which employ such light-filters or mirrors in conveying information. These variable transmittance light filters have included windows.

Devices of reversibly variable transmittance to electromagnetic radiation, wherein the transmittance is altered by electrochromic means, are well known in the art. Such electrochromic devices may be utilized in a fully integrated inside/outside rearview mirror system or as separate inside or outside rearview mirror systems.

Fig. 1 shows a typical electrochromic mirror device 10, having front and rear planar elements 12 and 16, respectively. A transparent conductive coating 14 is placed on the rear face of the front element 12, and another transparent conductive coating 18 is placed on the front face of rear element 16. A reflector (20a, 20b and 20c), typically comprising a silver metal layer 20a covered by a protective copper metal layer 20b, and one or more layers of protective paint 20c, is disposed on the rear face of the rear element 16. For clarity of description of such a structure, the front surface of the front glass element is sometimes referred to as the first surface, and the inside surface of the front glass element is sometimes referred to as the second surface. The inside surface of

front glass element is sometimes referred to as the second surface. The inside surface of the rear glass element is sometimes referred to as the third surface, and the back surface of the rear glass element is sometimes referred to as the fourth surface. The front and rear elements are held in a parallel and spaced-apart relationship by seal 22, thereby creating a chamber 26. The electrochromic medium 24 is contained in space 26. The electrochromic medium 24 is in direct contact with transparent electrode layers 14 and 18, through which passes electromagnetic radiation whose intensity is reversibly modulated in the device by a variable voltage or potential applied to electrode layers 14 and 18 through clip contacts and an electronic circuit (not shown).

The electrochromic medium 24 placed in space 26 may include surface-confined, electrode position-type or solution-phase-type electrochromic materials and combinations thereof. In an all solution-phase medium, the electrochemical properties of the solvent, optional inert electrolyte, anodic materials, cathodic materials, and any other components that might be present in the solution are preferably such that no significant electrochemical or other changes occur at a potential difference which oxidizes anodic material and reduces the cathodic material other than the electrochemical oxidation of the anodic material, electrochemical reduction of the cathodic material, and the self-erasing reaction between the oxidized form of the anodic material and the reduced form of the cathodic material.

In most cases, when there is no electrical potential difference between transparent conductors 14 and 18, the electrochromic medium 24 in space 26 is essentially colorless or nearly colorless, and incoming light (I_o) enters through front element 12, passes through transparent coating 14, electrochromic containing chamber 26, transparent coating 18, rear element 16, and reflects off layer 20a and travels back through the device and out front element 12. Typically, the magnitude of the reflected image (I_R) with no electrical potential difference is about 45 percent to about 85 percent of the incident light intensity (I_o). The exact value depends on many variables outlined below, such as, for example, the residual reflection (I'_R) from the front face of the front element, as well as secondary reflections from the interfaces between: the front element 12 and the front transparent electrode 14, the front transparent electrode 14 and the electrochromic medium 24, the electrochromic medium 24 and the second transparent electrode 18, and the second transparent electrode 18 and the rear element 16. These

reflections are well known in the art and are due to the difference in refractive indices between one material and another as the light crosses the interface between the two. If the front element and the back element are not parallel, then the residual reflectance (I'_R) or other secondary reflections will not superimpose with the reflected image (I_R) from mirror surface 20a, and a double image will appear (where an observer would see what appears to be double (or triple) the number of objects actually present in the reflected image).

There are minimum requirements for the magnitude of the reflected image depending in whether the electrochromic mirrors are placed on the inside or the outside of the vehicle. For example, according to current requirements from most automobile manufacturers, inside mirrors preferably have a high end reflectivity of at least 70 percent, and outside mirrors must have a high end reflectivity of at least 35 percent.

Electrode layers 14 and 18 are connected to electronic circuitry which is effective to electrically energize the electrochromic medium, such that when a potential is applied across the transparent conductors 14 and 18, electrochromic medium in space 26 darkens, such that incident light (I_o) is attenuated as the light passes toward the reflector 20a and as it passes back through after being reflected. By adjusting the potential difference between the transparent electrodes, such a device can function as a "gray-scale" device, with continuously variable transmittance over a wide range. For solution-phase electrochromic systems, when the potential between the electrodes is removed or returned to zero, the device spontaneously returns to the same, zero-potential, equilibrium color and transmittance as the device had before the potential was applied. Other electrochromic materials are available for making electrochromic devices. For example, the electrochromic medium may include electrochromic materials that are solid metal oxides, redox active polymers, and hybrid combinations of solution-phase and solid metal oxides or redox active polymers; however, the above-described solution-phase design is typical of most of the electrochromic devices presently in use.

U.S. Patent No. 5,818,625 discloses an electrochromic mirror having a third surface reflector. Such a design has advantages in that it is easier to manufacture because there are fewer layers to build into a device, *i.e.*, the third surface transparent electrode is not necessary when there is a third surface reflector/electrode.

In the past, information, images or symbols from displays, such as vacuum fluorescent displays, have been displayed on electrochromic rearview mirrors for motor vehicles with reflective layers on the fourth surface of the mirror. The display is visible to the vehicle occupant by removing all of the reflective layer on a portion of the fourth surface and placing the display in that area. Although this design works adequately due to the transparent conductors on the second and third surface to impart current to the electrochromic medium, presently no design is commercially available which allows a display device to be incorporated into a mirror that has a reflective layer on the third surface. Removing all of the reflective layer on the third surface in the area aligned with the display area or the glare sensor area causes severe residual color problems when the electrochromic medium darkens and clears because, although colorization occurs at the transparent electrode on the second surface, there is no corresponding electrode on the third surface in that corresponding area to balance the charge. As a result, the color generated at the second surface (across from the display area or the glare sensor area) will not darken or clear at the same rate as other areas with balanced electrodes. This color variation is significant and is very aesthetically unappealing to the vehicle occupants.

Similar problems exist for outside rearview mirror assemblies that include signal lights, such as turn signal lights, behind the rear surface of the mirror. Examples of such signal mirrors are disclosed in U.S. Patent Nos. 5,207,492, 5,361,190, and 5,788,357. By providing a turn signal light in an outside mirror assembly, a vehicle, or other vehicles travelling in the blind spot of the subject vehicle, will be more likely to notice when the driver has activated the vehicle's turn signal and thereby attempt to avoid an accident. Such mirror assemblies typically employ a dichroic mirror and a plurality of red LEDs mounted behind the mirror as the signal light source. The dichroic mirror includes a glass substrate and a dichroic reflective coating provided on the rear surface of the glass plate that transmits the red light generated by the LEDs as well as infrared radiation while reflecting all light and radiation having wavelengths less than that of red light. By utilizing a dichroic mirror, such mirror assemblies hide the LEDs when not in use to provide the general appearance of a typical rearview mirror, and allow the red light from such LEDs to pass through the dichroic mirror and be visible to drivers of vehicles behind and to the side of the vehicle in which such a mirror

assembly is mounted. Examples of such signal mirrors are disclosed in U.S. Patent Nos. 5,361,190 and 5,788,357.

In daylight, the intensity of the LEDs must be relatively high to enable those in other vehicles to readily notice the signal lights. Because the image reflected toward the driver is also relatively high in daylight, the brightness of the LEDs is not overly distracting. However, at night the same LED intensity could be very distracting, and hence, potentially hazardous. To avoid this problem, a day/night sensing circuit is mounted in the signal light subassembly behind the dichroic mirror to sense whether it is daytime or nighttime and toggle the intensity of the LEDs between two different intensity levels. The sensor employed in the day/night sensing circuit is most sensitive to red and infrared light so as to more easily distinguish between daylight conditions and the bright glare from the headlights of a vehicle approaching from the rear. Hence, the sensor may be mounted behind the dichroic coating on the dichroic mirror.

The dichroic mirrors used in the above-described outside mirror assemblies suffer from the same problems of many outside mirror assemblies in that their reflectance cannot be dynamically varied to reduce nighttime glare from the headlights of other vehicles.

Although outside mirror assemblies exist that include signal lights and other outside mirror assemblies exist that include electrochromic mirrors, signal lights have not been provided in mirror assemblies having an electrochromic mirror because the dichroic coating needed to hide the LEDs of the signal light typically cannot be applied to an electrochromic mirror, particularly those mirrors that employ a third surface reflector/electrode.

SUMMARY OF THE INVENTION

Accordingly, it is an aspect of the present invention to solve the above problems by providing an electrochromic rearview mirror assembly that includes a reflector formed as a continuous layer across the entire visible surface of the rear element of the mirror, even those regions that lie in front of a light source, such as a signal light, information display, or illuminator, or a light sensor or receptor, that is positioned behind the electrochromic mirror. Yet another aspect of the present invention is to provide an electrochromic mirror having a reflector that is at least partially transmissive at least in regions in front of a light source, such as a display, illuminator, or signal

light. Still another aspect of the present invention is to provide an electrochromic mirror having a partially reflective, partially transmissive reflector that does not have too yellow a hue and has relative color neutrality.

According to a first embodiment, it is a further aspect to provide the reflector as a third surface reflector. To achieve these and other aspects and advantages, the electrochromic mirror according to the present invention comprises a partially transmissive, partially reflective electrode disposed over substantially all of the front surface of the rear element. The electrochromic rearview mirror so constructed, has a reflectance of at least about 35% and a transmittance of at least about 5% in at least portions of the visible spectrum. The mirror preferably further exhibits relative color neutrality with a C* value of less than about 20. Further, the mirror preferably does not have a perceivable yellow hue and thus has a b* value less than about 15.

Another aspect of the present invention is to provide a rearview mirror assembly having a light emitting display assembly mounted behind the mirror within the mirror housing whereby spurious reflections and ghost images are substantially reduced or eliminated. To achieve this and other aspects and advantages, a rearview mirror assembly according to the present invention comprises either an electrically conductive third surface reflector or a fourth surface reflector, the reflective electrode/reflector being at least partially transmissive in at least a location in front of the display. The display has a front surface and is preferably mounted behind the rear surface of the rear element, such that the front surface of the display is not parallel with the rear surface of the mirror. Alternatively, the display may have a non-specular front surface or the front surface could be laminated directly onto the back of the mirror. As yet another alternative, an anti-reflection coating may be applied to the reflective surface(s) of the display and the front surface of the mirror. Still another alternative to achieve the above aspects and advantages is to provide at least one masking component that minimizes light that is emitted from the display from reflecting off of the reflector back toward the display and then reflecting back off the front surface of the display toward the front surface of the front element then on to the viewer.

Another aspect of the present invention is to provide an exterior rearview mirror assembly incorporating a light source for illuminating a portion of the exterior of the vehicle, such as the door handle and locking mechanism area of a vehicle door. To

achieve these and other aspects and advantages, an exterior rearview mirror assembly of the present invention comprises a light source behind the rear surface of a first element, the light source being positioned to emit light through the first element and through a region of a reflector that is at least partially transmissive toward a side of a vehicle. Such a rearview mirror assembly thus conveniently illuminates areas on the outside of the vehicle such as the door handles and locking mechanisms.

According to another embodiment, the electrochromic mirror of the present invention comprises a second electrode overlying the front surface of the rear element in contact with the electrochromic material. The second electrode includes a layer of reflective material and a coating of electrically conductive material that is at least partially transmissive and is disposed over substantially all of the front surface of the rear element. The second electrode further includes a region in front of an electronic device that is disposed behind the electrochromic mirror that is at least partially transmissive.

An additional aspect of the present invention is to provide a third surface reflector/electrode (*i.e.*, second electrode) that is at least partially reflective in those regions in front of the light source so as to provide an ascetically pleasing appearance. To achieve this and other aspects and advantages, either a thin layer of the reflective material may be applied to those regions in front of the electronic device or the electrically conductive coating underlying the reflective layer may be made of materials that are not only electrically conductive, but also partially reflective and partially transmissive.

To achieve the above and other aspects and advantages, the rearview mirror of the present invention alternatively comprises a mirror including a transparent substrate, a reflective coating formed on a surface of the substrate, and a partially transmissive/reflective area disposed within the reflective coating, the partially transmissive/reflective area having regions containing reflective material and regions substantially devoid of reflective material, and a light source mounted behind the partially transmissive/reflective area of the mirror for selectively projecting light through the mirror, wherein the reflective material is effective to reflect light through the substrate when the light reaches the reflective material after passing through the substrate.

These and other features, advantages, and objects of the present invention will be further understood and appreciated by those skilled in the art by reference to the following specification, claims, and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 is an enlarged cross-sectional view of a prior art electrochromic mirror assembly;

Fig. 2 is a front elevational view schematically illustrating an inside/outside electrochromic rearview mirror system for motor vehicles, where the inside and outside mirrors incorporate the mirror assembly of the present invention;

Figs. 3A-3G are partial cross-sectional views of alternative constructions of the electrochromic mirror according to the present invention as taken along line 3-3′ shown in Fig. 2;

Fig.4 is a partial cross-sectional view of the electrochromic mirror according to the present invention as taken along line 3-3′ shown in Fig. 2;

Figs. 5A-5E are partial cross-sectional views of additional alternative constructions of the electrochromic mirror according to the present invention as taken along lines 3-3′ shown in Fig. 2;

Fig. 6 is a front elevational view schematically illustrating an inside electrochromic rearview mirror incorporating the mirror assembly of the present invention;

Fig. 7 is a partial cross-sectional view of the electrochromic mirror shown in Fig. 6 taken along line 7-7′;

Fig. 8 is a perspective view of an outside automatic rearview mirror including a signal light and an electrical circuit diagram in block form of an outside rearview mirror assembly constructed in accordance with the present invention;

Fig. 9 is a front elevational view of a signal light subassembly that may be used in the outside mirror assembly of the present invention;

Fig. 10A is a partial cross-sectional view taken along line 10-10′ of Fig. 8 illustrating one construction of the outside rearview mirror of the present invention;

Fig. 10B is a partial cross-sectional view taken along line 10-10´ of Fig. 8 illustrating a second alternative arrangement of the outside rearview mirror constructed in accordance with the second embodiment of the present invention;

Fig. 10C is a partial cross-sectional view taken along lines 10-10´ of Fig. 8 illustrating a third alternative arrangement of the outside rearview mirror constructed in accordance with the second embodiment of the present invention;

Fig. 10D is a partial cross-sectional view taken along lines 10-10´ of Fig. 8 illustrating a fourth alternative arrangement of the outside rearview mirror constructed in accordance with another embodiment of the present invention;

Fig. 11 is a pictorial representation of two vehicles, one of which includes the signal mirror of the present invention;

Fig. 12 is a front elevational view of an automatic rearview mirror embodying the information display area of another embodiment of the present invention;

Fig. 13 is an enlarged cross-sectional view, with portions broken away for clarity of illustration, of the automatic rearview mirror illustrated in Fig. 12;

Fig. 14 is a front elevational view of the information display area, with portions broken away for clarity of illustration, of the automatic rearview mirror illustrated in Fig. 12;

Fig. 15 is a perspective view of a signal light assembly for use with another embodiment of the present invention;

Fig. 16 is a front elevational view of an outside rearview mirror assembly constructed in accordance with another embodiment of the present invention;

Fig. 17 is a partial cross-sectional view of the rearview mirror assembly shown in Fig. 16 taken along line 17-17´;

Fig. 18 is a perspective view of an exterior portion of an exemplary vehicle embodying the outside rearview mirror of the present invention as illustrated in Figs. 16 and 17;

Fig. 19A is a front perspective view of a mask bearing indicia in accordance with another aspect of the present invention;

Fig. 19B is a front perspective view of a rearview mirror constructed in accordance with another aspect of the present invention;

Fig. 20 is a front perspective view of a circuit board containing a plurality of light sources arranged in a configuration useful as a display in accordance with one aspect of the present invention; and

Fig. 21 is a cross-sectional view of a display and mirror constructed in accordance with one aspect of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 2 shows a front elevational view schematically illustrating an inside mirror assembly 110 and two outside rearview mirror assemblies 111a and 111b for the driver-side and passenger-side, respectively, all of which are adapted to be installed on a motor vehicle in a conventional manner and where the mirrors face the rear of the vehicle and can be viewed by the driver of the vehicle to provide a rearward view. Inside mirror assembly 110 and outside rearview mirror assemblies 111a and 111b may incorporate light-sensing electronic circuitry of the type illustrated and described in the above-referenced Canadian Patent No. 1,300,945, U.S. Patent No. 5,204,778, or U.S. Patent No. 5,451,822, and other circuits capable of sensing glare and ambient light and supplying a drive voltage to the electrochromic element. Mirror assemblies 110, 111a, and 111b are essentially identical in that like numbers identify components of the inside and outside mirrors. These components may be slightly different in configuration, but function in substantially the same manner and obtain substantially the same results as similarly numbered components. For example, the shape of the front glass element of inside mirror 110 is generally longer and narrower than outside mirrors 111a and 111b. There are also some different performance standards placed on inside mirror 110 compared with outside mirrors 111a and 111b. For example, inside mirror 110 generally, when fully cleared, should have a reflectance value of about 70 percent to about 85 percent or higher, whereas the outside mirrors often have a reflectance of about 50 percent to about 65 percent. Also, in the United States (as supplied by the automobile manufacturers), the passenger-side mirror 111b typically has a spherically bent or convex shape, whereas the driver-side mirror 111a and inside mirror 110 presently must be flat. In Europe, the driver-side mirror 111a is commonly flat or aspheric, whereas the passenger-side mirror 111b has a convex shape. In Japan, both outside mirrors have a convex shape.

Figs. 3A-3G illustrate various alternative constructions for an electrochromic rearview mirror of the present invention, particularly when a light source 170, such as an information display (*i.e.*, compass/temperature display) or signal light, is positioned within the mirror assembly behind the electrochromic mirror

Fig. 3A shows a cross-sectional view of mirror assembly having a front transparent element 112 having a front surface 112a and a rear surface 112b, and a rear element 114 having a front surface 114a and a rear surface 114b. For clarity of description of such a structure, the following designations will be used hereinafter. The front surface 112a of the front glass element will be referred to as the first surface, and the back surface 112b of the front glass element as the second surface. The front surface 114a of the rear glass element will be referred to as the third surface, and the back surface 114b of the rear glass element as the fourth surface. A chamber 125 is defined by a layer of transparent conductor 128 (carried on second surface 112b), a reflector/electrode 120 (disposed on third surface 114a), and an inner circumferential wall 132 of sealing member 116. An electrochromic medium 126 is contained within chamber 125.

As broadly used and described herein, the reference to an electrode or layer as being "carried" on a surface of an element, refers to both electrodes or layers that are disposed directly on the surface of an element or disposed on another coating, layer or layers that are disposed directly on the surface of the element.

Front transparent element 112 may be any material which is transparent and has sufficient strength to be able to operate in the conditions, *e.g.*, varying temperatures and pressures, commonly found in the automotive environment. Front element 112 may comprise any type of borosilicate glass, soda lime glass, float glass, or any other material, such as, for example, a polymer or plastic, that is transparent in the visible region of the electromagnetic spectrum. Front element 112 is preferably a sheet of glass. The rear element must meet the operational conditions outlined above, except that it does not need to be transparent in all applications, and therefore may comprise polymers, metals, glass, ceramics, and preferably is a sheet of glass.

The coatings of the third surface 114a are sealably bonded to the coatings on the second surface 112b in a spaced-apart and parallel relationship by a seal member 116 disposed near the outer perimeter of both second surface 112b and third surface 114a.

Seal member 116 may be any material that is capable of adhesively bonding the coatings on the second surface 112b to the coatings on the third surface 114a to seal the perimeter such that electrochromic material 126 does not leak from chamber 125. Optionally, the layer of transparent conductive coating 128 and the layer of reflector/electrode 120 may be removed over a portion where the seal member is disposed (not the entire portion, otherwise the drive potential could not be applied to the two coatings). In such a case, seal member 116 must bond well to glass.

The performance requirements for a perimeter seal member 116 used in an electrochromic device are similar to those for a perimeter seal used in a liquid crystal device (LCD), which are well known in the art. U.S. Patent No. 5,818,625 discloses these properties and suitable seal materials and constructions.

The layer of a transparent electrically conductive material 128 is deposited on the second surface 112b to act as an electrode. Transparent conductive material 128 may be any material which bonds well to front element 112, is resistant to corrosion to any materials within the electrochromic device, resistant to corrosion by the atmosphere, has minimal diffuse or specular reflectance, high light transmission, near neutral coloration, and good electrical conductance. Transparent conductive material 128 may be any of the materials described in U.S. Patent No. 5,818,625, and have the thicknesses disclosed therein. If desired, an optional layer or layers of a color suppression material 130 may be deposited between transparent conductive material 128 and the second surface 112b to suppress the reflection of any unwanted portions of the electromagnetic spectrum.

In accordance with the present Invention, a combination reflector/electrode 120 is preferably disposed on third surface 114a. Reflector/electrode 120 comprises at least one layer of a reflective material 121 which serves as a mirror reflectance layer and also forms an integral electrode in contact with and in a chemically and electrochemically stable relationship with any constituents in an electrochromic medium. By combining the "reflector" and "electrode" and placing both on the third surface, several unexpected advantages arise which not only make the device manufacture less complex, but also allow the device to operate with higher performance. The following will outline the exemplary advantages of the combined reflector/electrode of the present invention.

First, the combined reflector/electrode 120 on the third surface generally has higher conductance than a conventional transparent electrode and previously used

reflector/electrodes, which will allow greater design flexibility. One can either change the composition of the transparent conductive electrode on the second surface to one that has lower conductance (being cheaper and easier to produce and manufacture) while maintaining coloration speeds similar to that obtainable with a fourth surface reflector device, while at the same time decreasing substantially the overall cost and time to produce the electrochromic device. If, however, performance of a particular design is of utmost importance, a moderate to high conductance transparent electrode can be used on the second surface, such as, for example, ITO, IMI, etc. The combination of a high conductance (*i.e.*, less than 250 Ω/□, preferably less than 15 Ω/□) reflector/electrode on the third surface and a high conductance transparent electrode on the second surface will not only produce an electrochromic device with more even overall coloration, but will also allow for increased speed of coloration and clearing. Furthermore, in fourth surface reflector mirror assemblies there are two transparent electrodes with relatively low conductance, and in previously used third surface reflector mirrors there is a transparent electrode and a reflector/electrode with relatively low conductance and, as such, a long buss bar on the front and rear element to bring current in and out is necessary to ensure adequate coloring speed. The third surface reflector/electrode of the present invention has a higher conductance and therefore has a very even voltage or potential distribution across the conductive surface, even with a small or irregular contact area. Thus, the present invention provides greater design flexibility by allowing the electrical contact for the third surface electrode to be very small while still maintaining adequate coloring speed.

Second, a third surface reflector/electrode helps improve the image being viewed through the mirror. Fig. 1 shows how light travels through a conventional fourth surface reflector device. In the fourth surface reflector, the light travels through: the first glass element, the transparent conductive electrode on the second surface, the electrochromic media, the transparent conductive electrode on the third surface, and the second glass element, before being reflected by the fourth surface reflector. Both transparent conductive electrodes exhibit highly specular transmittance but also possess diffuse transmittance and reflective components, whereas the reflective layer utilized in any electrochromic mirror is chosen primarily for its specular reflectance. By diffuse reflectance or transmittance component, we mean a material which reflects or transmits a

portion of any light impinging on it according to Lambert's law whereby the light rays are spread-about or scattered. By specular reflectance or transmittance component, we mean a material which reflects or transmits light impinging on it according to Snell's laws of reflection or refraction. In practical terms, diffuse reflectors and transmitters tend to slightly blur images, whereas specular reflectors show a crisp, clear image. Therefore, light traveling through a mirror having a device with a fourth surface reflector has two partial diffuse reflectors (on the second and third surface) which tend to blur the image, and a device with a third surface reflector/electrode of the present invention only has one diffuse reflector (on the second surface).

Additionally, because the transparent electrodes act as partial diffuse transmitters, and the farther away the diffuse transmitter is from the reflecting surface the more severe the blurring becomes, a mirror with a fourth surface reflector appears significantly more hazy than a mirror with a third surface reflector. For example, in the fourth surface reflector shown in Fig. 1, the diffuse transmitter on the second surface is separated from the reflector by the electrochromic material, the second conductive electrode, and the second glass element. The diffuse transmitter on the third surface is separated from the reflector by the second glass element. By incorporating a combined reflector/electrode on the third surface in accordance with the present invention, one of the diffuse transmitters is removed, and the distance between the reflector and the remaining diffuse transmitter is closer by the thickness of the rear glass element. Therefore, the third surface metal reflector/electrode of the present invention provides an electrochromic mirror with a superior viewing image.

Finally, a third surface metal reflector/electrode improves the ability to reduce double imaging in an electrochromic mirror. As stated above, there are several interfaces where reflections can occur. Some of these reflections can be significantly reduced with color suppression or anti-reflective coatings; however, the most significant "double imaging" reflections are caused by misalignment of the first surface and the surface containing the reflector, and the most reproducible way of minimizing the impact of this reflection is by ensuring both glass elements are parallel. Presently, convex glass is often used for the passenger side outside mirror and aspheric glass is sometimes used for the driver side outside mirror to increase the field of view and reduce potential blind spots. However, it is difficult to reproducibly bend successive elements of glass having

identical radii of curvature. Therefore, when building an electrochromic mirror, the front glass element and the rear glass element may not be perfectly parallel (do not have identical radii of curvature), and therefore, the otherwise controlled double imaging problems become much more pronounced. By iocorporating a combined reflector electrode on the third surface of the device in accordance with the present invention, light does not have to travel through the rear glass element before being reflected, and any double imaging that occurs from the elements being out of parallel will be significantly reduced.

It is desirable in the construction of outside rearview mirrors to incorporate thinner glass in order to decrease the overall weight of the mirror so that the mechanisms used to manipulate the orientation of the mirror are not overloaded. Decreasing the weight of the device also improves the dynamic stability of the mirror assembly when exposed to vibrations. Heretofore, no electrochromic mirrors incorporating a solution-phase electrochromic medium and two thin glass elements have been commercially available, because thin glass suffers from being flexible and prone to warpage or breakage, especially when exposed to extreme environments. This problem is substantially improved by using an improved electrochromic device incorporating two thin glass elements having an improved gel material. This improved device is disclosed in commonly assigned U.S. Patent No. 5,940,201 The addition of the combined reflector/electrode onto the third surface of the device further helps remove any residual double imaging resulting from the two glass elements being out of parallel.

The most importaot factors for obtaining a reliable electrochromic mirror having a third surface reflector/electrode 120 are that the reflector/electrode have sufficient reflectance and that the mirror incorporating the reflector/electrode has adequate operational life. Regarding reflectance, the automobile manufacturers prefer a reflective mirror for the inside mirror having a reflectivity of at least 60 percent, whereas the reflectivity requirements for an outside mirror are less stringent and generally must be at least 35 percent.

To produce an electrochromic mirror with 70 percent reflectance, the reflector must have a reflectance higher than 70 percent because the electrochromic medium in front of the reflector reduces the reflectance from the reflector interface as compared to having the reflector in air due to the medium having a higher index of refraction as

compared to air. Also, the glass, the transparent electrode, and the electrochromic medium even in its clear state are slightly light absorbing. Typically, if an overall reflectance of 65 percent is desired, the reflector must have a reflectance of about 75 percent.

Regarding operational life, the layer or layers that comprise the reflector/electrode 120 must have adequate bond strength to the peripheral seal, the outermost layer must have good shelf life between the time it is coated and the time the mirror is assembled, the layer or layers must be resistant to atmospheric and electrical contact corrosion, and must bond well to the glass surface or to other layers disposed beneath it, *e.g.*, the base or intermediate layer (172). The overall sheet resistance for the reflector/electrode 120 may range from about 0.01 $\Omega/\Box$ to about 100 $\Omega/\Box$ and preferably ranges from about 0.2 $\Omega/\Box$ to about 25 $\Omega/\Box$. As will be discussed in more detail below, improved electrical interconnections using a portion of the third surface reflector/electrode as a high conductance contact or buss bar for the second surface transparent conductive electrode may be utilized when the conductance of the third surface reflector/electrode is below about 2 $\Omega/\Box$.

Referring to Fig. 3A for one embodiment of the present invention, a reflector/electrode that is made from a single layer of a reflective silver or silver alloy 121 is provided that is in contact with at least one solution-phase electrochromic material. The layer of silver or silver alloy covers the entire third surface 114a of second element 114 with the exception of a window area 146 in front of light source 170. The reflective silver alloy means a homogeneous or non-homogeneous mixture of silver and one or more metals, or an unsaturated, saturated, or supersaturated solid solution of silver and one or more metals. U.S. Patent No. 5,818,625 discloses the relevant properties for a number of different materials suitable for the reflector/electrode 120 of the present invention. The only materials having reflectance properties suitable for use as a third surface reflector/electrode in contact with at least one solution-phase electrochromic material for an inside electrochromic mirror for a motor vehicle are aluminum, silver, and silver alloys. Aluminum performs very poorly when in contact with solution-phase material(s) in the electrochromic medium because aluminum reacts with or is corroded by these materials. The reacted or corroded aluminum is non-reflective and non-conductive and will typically dissolve off, flake off, or delaminate

from the glass surface. Silver is more stable than aluminum but can fail when deposited over the entire third surface because it does not have long shelf life and is not resistant to electrical contact corrosion when exposed to the environmental extremes found in the motor vehicle environment. These environmental extremes include temperatures ranging from about -40°C to about 85°C, and humidities ranging from about 0 percent to about 100 percent. Further, mirrors must survive at these temperatures and humidities for coloration cycle lives up to 100,000 cycles.

When silver is alloyed with certain materials to produce a third surface reflector/electrode, the deficiencies associated with silver metal and aluminum metal can be overcome. Suitable materials for the reflective layer are alloys of silver/palladium, silver/gold, silver/platinum, silver/rhodium, silver/titanium, etc. The amount of the solute material, *i.e.*, palladium, gold, etc., can vary. The silver alloys surprisingly retain the high reflectance and low sheet resistance properties of silver, while simultaneously improving their contact stability, shelf life, and also increasing their window of potential stability when used as electrodes in propylene carbonate containing 0.2 molar tetraethylammonium tetrafluoroborate. The presently preferred materials for reflective layer 121 are silver/gold, silver/platinum, and silver/palladium.

Electrode 120 further includes a coating 172 of electrically conductive material that is applied over substantially all of the front surface 114a of rear element 114. Coating 172 is preferably at least partially transmissive so as to enable light emitted from light source 170 to be transmitted through the electrochromic mirror via window 146. By providing electrically conductive coating 172 throughout the entire area of window 146, the electrochromic media 125 in the region of window 146 will respond to the voltage applied to the clips as though window 146 was not even present. Coating 172 may be a single layer of a transparent conductive material. Such a single layer may be made of the same materials as that of first electrode 128 (*i.e.*, indium tin oxide (ITO), etc.).

Transparent electrodes made of ITO or other transparent conductors have been optimized at thicknesses to maximize the transmission of visible light (typically centered around 550 nm). These transmission optimized thicknesses are either very thin layers (<300 Å) or layers optimized at what is commonly called ½ wave, full wave, 1½ wave, etc. thickness. For ITO, the ½ wave thickness is about 1400 Å and the full wave

thickness is around 2800 Å. Surprisingly, these thicknesses are not optimum for transflective (*i.e.*, partially transmissive, partially reflective) electrodes with a single underlayer of a transparent conductor under a metal reflector such as silver or silver alloys. The optimum thicknesses to achieve relative color neutrality of reflected light are centered around ¼ wave, ¾ wave, 1¼ wave, etc. optical thicknesses for light of 500 nm wavelength. In other words the optimal optical thickness for such a layer when underlying a metal reflector such as silver or silver alloy is $m\lambda/4$, where λ is the wavelength of light at which the layer is optimized (*e.g.*, 500 nm) and m is an odd integer. These optimum thicknesses are ¼ wave different from the transmission optima for the same wavelength. Such a single layer may have a thickness of between 100 Å and 3500 Å and more preferably between 200 Å and 250 Å, and a sheet resistivity of between about 3 Ω/□ and 300 Ω/□ and preferably less than about 100 Ω/□.

Layer 121 is preferably made of silver or a silver alloy. The thickness of reflective layer 121 in the arrangement shown in Fig. 3A is preferably between 30 Å and 800 Å. The thickness of layer 121 will depend on the desired reflectance and transmittance properties. For an inside rearview mirror, layer 121 preferably has a reflectance of at least 60 percent and a transmittance through window 146 of 10 to 50 percent. For an outside mirror, the reflectance is preferably above 35 percent and the transmittance is preferably approximately 10 to 50 percent and more preferably at least 20 percent for those regions that are in front of one of the lights of a signal light (as described in more detail below).

The various layers of reflector/electrode 120 can be deposited by a variety of deposition procedures, such as RF and DC sputtering, e-beam evaporation, chemical vapor deposition, electrode position, etc., that will be known to those skilled in the art. The preferred alloys are preferably deposited by sputtering (RF or DC) a target of the desired alloy or by sputtering separate targets of the individual metals that make up the desired alloy, such that the metals mix during the deposition process and the desired alloy is produced when the mixed metals deposit and solidify on the substrate surface.

Window 146 in layer 121 may be formed by masking window area 146 during the application of the reflective material. At this same time, the peripheral region of the third surface may also be masked so as to prevent materials such as silver or silver alloy (when used as the reflective material) from being deposited in areas to which seal 116

must adhere, so as to create a stronger bond between seal 116 and coating 172. Additionally, an area in front of sensor 160 (Fig. 2) may also be masked. Alternatively, an adhesion promoting material can be added to the seal to enhance adhesion between the seal and the silver/silver alloy layer as described in U.S. Patent Application No. 09/158,423 entitled "IMPROVED SEAL FOR ELECTROCHROMIC DEVICES."

It is sometimes desirable to provide an optional flash over-coat layer (not shown) over reflective layer 121, such that it (and not the reflective layer 121) contacts the electrochromic medium. This flash over-coat layer must have stable behavior as an electrode, it must have good shelf life, it must bond well to the reflective layer 121, and maintain this bond when the seal member 116 is bonded thereto. It must be sufficiently thin, such that it does not completely block the reflectivity of reflective layer 121. When a very thin flash over-coat layer is placed over the highly reflecting layer, then the reflective layer 121 may be silver metal or a silver alloy because the flash layer protects the reflective layer while still allowing the highly reflecting layer 121 to contribute to the reflectivity of the mirror. In such cases, a thin (between about 25 Å and about 300 Å) layer of rhodium, platinum, or molybdenum is deposited over the reflective layer 121. When reflective layer 121 is silver, the flash layer may also be a silver alloy.

Referring again to Fig. 3A, chamber 125, defined by transparent conductor 128 (disposed on front element rear surface 112b), reflector/electrode 120 (disposed on rear element front surface 114a), and an inner circumferential wall 132 of sealing member 116, contains an electrochromic medium 126. Electrochromic medium 126 is capable of attenuating light traveling therethrough and has at least one solution-phase electrochromic material in intimate contact with reflector/electrode 120 and at least one additional electroactive material that may be solution-phase, surface-confined, or one that plates out onto a surface. However, the presently preferred media are solution-phase redox electrochromics, such as those disclosed in above-referenced U.S. Patent Nos. 4,902,108, 5,128,799, 5,278,693, 5,280,380, 5,282,077, 5,294,376, and 5,336,448. U.S. Patent Application No. 08/832,596, entitled "AN IMPROVED ELECTROCHROMIC MEDIUM CAPABLE OF PRODUCING A PRE-SELECTED COLOR" discloses electrochromic media that are perceived to be gray throughout their normal range of operation. If a solution-phase electrochromic medium is utilized, it may

be inserted into chamber 125 through a sealable fill port through well-known techniques, such as vacuum backfilling and the like.

Referring again to Fig. 2, rearview mirrors embodying the present invention preferably include a bezel 144, which extends around the entire periphery of each individual assembly 110, 111a, and/or 111b. The bezel 144 conceals and protects the spring clips, and the peripheral edge portions of the sealing member and both the front and rear glass elements (112 and 114, respectively). A wide variety of bezel designs are well known in the art, such as, for example, the bezel taught and claimed in above-referenced U.S. Patent No. 5,448,397. There are also a wide variety of housings well known in the art for attaching the mirror assembly 110 to the inside front windshield of an automobile, or for attaching the mirror assemblies 111a and 111b to the outside of an automobile. A preferred mounting bracket is disclosed in above-referenced U.S. Patent No. 5,337,948.

The electrical circuit preferably incorporates an ambient light sensor (not shown) and a glare light sensor 160, the glare light sensor being positioned either behind the mirror glass and looking through a section of the mirror with the reflective material completely or partially removed, or the glare light sensor can be positioned outside the reflective surfaces, *e.g.*, in the bezel 144 or as described below, the sensor can be positioned behind a uniformly deposited transflective coating. Additionally, an area or areas of the electrode and reflector, such as 146, may be completely removed or partially removed as described below to permit a vacuum fluorescent display, such as a compass, clock, or other indicia, to show through to the driver of the vehicle or as also described below, this light emitting display assembly can be shown through a uniformly deposited transflective coating. The present invention is also applicable to a mirror which uses only one video chip light sensor to measure both glare and ambient light and which is further capable of determining the direction of glare. An automatic mirror on the inside of a vehicle, constructed according to this invention, can also control one or both outside mirrors as slaves in an automatic mirror system.

It is preferred but not essential that the third surface reflector/electrode 120 be maintained as the cathode in the circuitry because this eliminates the possibility of anodic dissolution or anodic corrosion that might occur if the reflector/electrode was used as the anode. If certain silver alloys are used, the positive potential limit of stability extends

out far enough, *e.g.*, 1.2 V, that the silver alloy reflector/electrode could safely be used as the anode in contact with at least one solution-phase electrochromic material.

An alternative construction to that shown in Fig. 3A is shown in Fig. 3B, where electrically conductive coating 172 is formed of a plurality of layers 174 and 176. For example, coating 172 may include a first base layer 174 applied directly to front surface 114a of rear element 114, and an intermediate second layer 176 disposed on first layer 174. First layer 174 and second layer 176 are preferably made of materials that have relatively low sheet resistivity and that are at least partially transmissive. The materials forming layers 174 and 176 may also be partially reflective. If the light emitting display behind the partially transmissive window area 146 must be viewed often in bright ambient conditions or direct sunlight, it may be desirable to keep the reflectivity of the window area to a minimum by using metals with low reflectivity or other dark, black or transparent coatings that are electrically conductive.

The material forming layer 174 should exhibit adequate bonding characteristics to glass or other materials of which rear element 114 may be formed, while the material forming layer 176 should exhibit adequate properties so as to bond to the material of layer 174 and provide a good bond between the applied layer 121 and seal 116. Thus, the material used for layer 174 is preferably a material selected from the group consisting essentially of: chromium, chromium-molybdenum-nickel alloys, nickel-iron-chromium alloys, silicon, tantalum, stainless steel, and titanium. In the most preferred embodiment, layer 174 is made of chromium. The material used to form second layer 176 is preferably a material selected from the group consisting essentially of, but not limited to: molybdenum, rhodium, nickel, tungsten, tantalum, stainless steel, gold, titanium, and alloys thereof. In the most preferred embodiment, second layer 176 is formed of nickel, rhodium, or molybdenum. If first layer 174 is formed of chromium, layer 174 preferably has a thickness of between 5 Å and 50 Å. If the layer of chromium is much thicker, it will not exhibit sufficient transmittance to allow light from a light source 170, such as a display or signal light, to be transmitted through window 146. The thickness of layer 176 is selected based upon the material used so as to allow between 10 to 50 percent light transmittance through both of layers 174 and 176. Thus, for a second layer 176 formed of either rhodium, nickel, or molybdenum, layer 176 is preferably between 50 Å and 150 Å. While the thicknesses of layers 174 and 176 are

preferably selected to be thin enough to provide adequate transmittance, they must also be thick enough to provide for adequate electrical conductivity so as to sufficiently clear or darken electrochromic media 125 in the region of window 146. The coating 172 should thus have a sheet resistivity of less than 100 Ω/□ and preferably less than 50 Ω/□ to 60 Ω/□.

The arrangement shown in Fig. 3B provides several advantages over the construction shown and described with respect to Fig. 3A. Specifically, the metals used in forming coating 172 contribute to the total reflectance of reflector electrode 120. Accordingly, the layer of the reflective material 121 need not be made as thick. If, for example, silver or a silver alloy is used to form layer 121, the layer of thickness is between 50 Å and 150 Å, thereby eliminating some of the material costs in providing the reflective layer. Further, the use of reflective metals in forming coating 172 provides for a degree of reflectance within window 146, thereby providing a much more ascetically pleasing appearance than if window 146 were devoid of any reflective material whatsoever. Ideally, coating 172 provides between 30 and 40 percent reflectivity in window 146. If the reflectance in window 146 is too high, bright light will tend to wash out the display in the sense that it eliminates the contrast between the light of the display and light reflecting outward from coating 172.

Another benefit of utilizing metals to form conductive coating 172 is that such metals are much easier and less expensive to process than metal oxides, such as indium tin oxide. Such metal oxides require application in oxygen-rich chambers at very high temperatures, whereas metal layers may be deposited without special oxygen chambers and at much lower temperatures. Thus, the process for applying multiple metal layers consumes much less energy and is much less expensive than the processes for forming metal oxide layers.

A third alternate arrangement for the electrochromic mirror of the present invention is shown in Fig. 3C. The construction shown in Fig. 3C is essentially the same as that shown in Fig. 3B except that a thin silver or silver alloy layer 178 is formed on conductive coating 172 within window 146. By providing only a thin layer 178 of reflective material in window 146, adequate transmittance may still be provided through window 146 while increasing the reflectivity and electrical conductivity in that area. Layer 178 may have a thickness of between 40 Å and 150 Å, whereas the layer of

reflective material 121 in the other areas may have a thickness in the order of between 200 Å and 1000 Å. The thin layer 178 of reflective material may be formed by initially masking the area of window 178 while applying a portion of reflective layer 121 and then removing the mask during deposition of the remainder of layer 121. Conversely, a thin layer of reflective material may first be deposited and then a mask may be applied over window 146 while the remainder of reflective layer 121 is deposited. As will be apparent to those skilled in the art, thin layer 178 may also be formed without masking by depositing reflective layer 121 to its full thickness and subsequently removing a portion of layer 121 in the region of window 146.

A modification of the configuration shown in Fig. 3C is illustrated in Fig. 3D. As will be apparent from a comparison of the drawings, the construction of Fig. 3D only differs from that shown in Fig. 3C in that layers 174 and 176 constituting conductive coating 172 are made thinner (designated as thin layers 180 and 181) in the region of reflector/electrode 120 that is in front of light source 170. As such, thin layer 180 may have a thickness of between 5 Å and 50 Å, whereas layer 174 may have thicknesses anywhere between 100 Å and 1000 Å. Similarly, thin layer 181 may be made of the same material as layer 176 but would have a thickness of between 50 Å and 150 Å, while layer 176 may have thicknesses on the order of 100 Å to 1000 Å. Thus, with the construction shown in Fig. 3D, the electrical conductivity, reflectivity, and transmittance within region 146 may be optimized within that region while enabling the reflectance and electrical conductivity in the other regions to be optimized without concern as to the transmittance in those areas.

Fig. 3E shows yet another alternative construction for second electrode 120. In the construction shown in Fig. 3E, second electrode 120 includes an electrically conductive coating 172 and a reflective coating 178 formed over the entire third surface 114a of the mirror. By making reflective coating 178 uniformly partially transmissive, a light source, such as a display or signal light, may be mounted in any location behind the mirror and is not limited to positioning behind any particular window formed in second electrode 120. Again, for a rearview mirror, second electrode 120 preferably has a reflectance of at least 35 percent for an outside mirror and at least 60 percent for an inside mirror and a transmittance of preferably at least 10 percent. Conductive coating 172 is preferably a single layer of ITO or other transparent conductive materials, but

may also consist of one or more layers of the partially reflective/partially transmissive electrically conductive materials discussed above.

Reflective coating 178 may be constructed using a single, relatively thin, layer of a reflective electrically conductive material such as silver, silver alloy, or the other reflective materials discussed above. If the reflective material is silver or a silver alloy, the thickness of such a thin layer should be limited to about 500 Å or less, and a transparent conductive material, such as ITO or the like, should be utilized as electrically conductive layer 172, such that second electrode 120 may have sufficient transmittance to allow a display or signal light to be viewed from behind the mirror. On the other hand, the thickness of the single layer of reflective material should be about 10 Å or more depending upon the material used to ensure sufficient reflectivity.

To illustrate the features and advantages of an electrochromic mirror constructed in accordance with the embodiment shown in Fig. 3E, ten examples are provided below. In these examples, references are made to the spectral properties of models of electrochromic mirrors constructed in accordance with the parameters specified in each example. In discussing colors, it is useful to refer to the Commission Internationale de l'Eclairage's (CIE) 1976 CIELAB Chromaticity Diagram (commonly referred to as the $L^*a^*b^*$ chart). The technology of color is relatively complex, but a fairly comprehensive discussion is given by F.W. Billmeyer and M. Saltzman in *Principles of Color Technology*, 2nd Edition, J. Wiley and Sons Inc. (1981), and the present disclosure, as it relates to color technology and terminology, generally follows that discussion. On the $L^*a^*b^*$ chart, L^* defines lightness, a^* denotes the red/green value, and b^* denotes the yellow/blue value. Each of the electrochromic media has an absorption spectra at each particular voltage that may be converted to a three number designation, their $L^*a^*b^*$ values. To calculate a set of color coordinates, such as $L^*a^*b^*$ values, from the spectral transmission or reflectance, two additional items are required. One is the spectral power distribution of the source or illuminant. The present disclosure uses CIE Standard Illuminant A to simulate light from automobile headlamps and uses CIE Standard Illuminant D_{65} to simulate daylight. The second item needed is the spectral response of the observer. The present disclosure uses the 2 degree CIE standard observer. The illuminant/observer combination generally used for mirrors is then represented as A/2 degree and the combination generally used for windows is represented as D_{65}/2 degree.

Many of the examples below refer to a value Y from the 1931 CIE Standard since it corresponds more closely to the spectral reflectance than L^*. The value C^*, which is also described below, is equal to the square root of $(a^*)^2+(b^*)^2$, and hence, provides a measure for quantifying color neutrality.

It should be noted that the optical constants of materials vary somewhat with deposition method and conditions employed. These differences can have a substantial effect on the actual optical values and optimum thicknesses used to attain a value for a given coating stock.

According to a first example, an electrochromic mirror was modeled having a back plate 114 (Fig. 3E) of glass, a layer 172 of ITO of approximately 2000 Å, a layer 178 of an alloy of silver containing 6 percent gold (hereinafter referred to as 6Au94Ag) of approximately 350 Å, an electrochromic fluid/gel layer 125 having a thickness of approximately 140 microns, a layer 128 of approximately 1400 Å of ITO, and a glass plate 112 of 2.1 mm. Using D65 illuminant at 20 degree angle of incidence, the model outputs were $Y=70.7$, $a^*=+1$, and $b^*=+9.5$. This model also indicated a spectrally dependent transmittance that was 15 percent over the blue-green region decreasing in the red color region of the spectrum to approximately 17 percent in the blue-green region of the spectrum. Elements were constructed using the values and the model as target parameters for thickness, and the actual color, and reflection values corresponded closely to those models with transmission values of approximately 15 percent in the blue and green region. In this example, 1400 Å ITO (1/2 wave) would produce a far more yellow element (b^* of approximately 18).

Typically, thin silver or silver alloy layers are higher in blue-green transmission and lower in blue-green light reflection which imparts a yellow hue to the reflected image. The 2000 Å ITO underlayer of approximately 3/4 wave in thickness supplements the reflection of blue-green light which results in a more neutral hue in reflection. Other odd quarter wave multiples (*i.e.*, 1/4, 5/4, 7/4, etc.) are also effective in reducing reflected color hue. It should be noted that other transparent coatings, such as (F)SnO or (AL)ZnO, or a combination of dielectric, semi-conductive, or conductive coatings, can be used to supplement blue-green reflection and produce a more neutral reflected hue in the same manner.

According to a second example of the embodiment illustrated in Fig. 3E, an electrochromic mirror was modeled having a back plate 114 of glass, layer 172 including a sublayer of titanium dioxide of approximately 441 Å and a sublayer of ITO of 200 Å, a layer 178 of 6Au94Ag of approximately 337 Å, an electrochromic fluid/gel 125 having a thickness of approximately 140 microns, a layer 128 of approximately 1400 Å of ITO, and a glass plate 112 of 2.1 mm. In air, the model of the conductive thin film 120 on glass 114 for this example, using D65 illuminant at 20 degree angle of incidence, exhibited values of approximately $Y=82.3$, $a^*=0.3$, and $b^*=4.11$. This model also indicated a relatively broad and uniform transmittance of 10-15 percent across most of the visible spectrum, making it an advantageous design for an interior rearview mirror with a multi-colored display or a white light display or illuminator. When this back plate system 114, 120 is incorporated into an electrochromic mirror, the predicted overall reflectance decreases and the transmittance increases.

According to a third example of an electrochromic mirror constructed as shown in Fig. 3E, an electrochromic mirror was modeled having a back plate 114 of glass, a layer 172 including a sublayer of titanium dioxide of approximately 407 Å and a sublayer of ITO of 200 Å, a layer 178 of 6Au94Ag of approximately 237 Å, an electrochromic fluid/gel layer 125 having a thickness of approximately 140 microns, a layer 128 of approximately 1400 Å of ITO, and a glass plate 112 of 2.1 mm. In air, the model of the conductive thin film 120 on glass 114, for this example, using D65 illuminant at 20 degree angle of incidence, exhibited values of approximately $Y=68.9$, $a^*=0.03$, and $b^*=1.9$. This model also indicated a relatively broad and uniform transmittance of approximately 25 to 28 percent across most of the visible spectrum, making it an advantageous design for an exterior rearview mirror with a multi-color display or a white light display or illuminator. When this back plate system 114, 120 is incorporated into an electrochromic mirror, the predicted overall reflectance decreases and the transmittance increases.

According to a fourth example of the embodiment shown in Fig. 3E, an electrochromic mirror was modeled having a back plate 114 of glass, a layer 172 including a sublayer of titanium dioxide of approximately 450 Å and a sublayer of ITO of 1600 Å, a layer 178 of 6Au94Ag of approximately 340 Å, an electrochromic fluid/gel layer 125 having a thickness of approximately 140 microns, a layer 128 of

approximately 1400 Å of ITO, and a glass plate 112 of 2.1 mm. In air, the model of the conductive thin film 120 on glass 114, for this example, using D65 illuminant at 20 degree angle of incidence, exhibited values of approximately $Y=80.3$, $a^*=-3.45$, and $b^*=5.27$. This model also indicated a relative transmittance peak at about 600 nm of approximately 17 percent. When this back plate system 114, 120 is incorporated into an electrochromic mirror, the predicted overall reflectance decreases and the transmittance increases. As one compares this stack to the second example, it illustrates, in part, a principle of repeating optima in the primarily transmissive layer or layers (*e.g.*, layer 172) of these designs as one increases their thickness or thicknesses. The optima will be determined by several factors which will include good color neutrality, reflection, and transmission.

According to a fifth example of the embodiment shown in Fig. 3E, an electrochromic mirror was modeled having a back plate 114 of glass; a layer 172 including a sublayer of titanium dioxide of approximately 450 Å, a sublayer of ITO of 800 Å, a sublayer of silica of 50 Å, and an additional sublayer of ITO of 800 Å; a layer 178 of 6Au94Ag of approximately 340 Å; an electrochromic fluid/gel layer 125 having a thickness of approximately 140 microns, a layer 128 of approximately 1400 Å of ITO; and a glass plate 112 of 2.1 mm. In air, the model of the conductive thin film 120 on glass 114, for this example, using D65 illuminant at 20 degree angle of incidence, exhibited values of approximately $Y=80.63$, $a^*=-4.31$, and $b^*=6.44$. This model also indicated a relative transmittance peak at about 600 nm of approximately 17 percent. When this back plate system is incorporated into an electrochromic mirror, the predicted overall reflectance decreases and the transmittance increases. This stack also demonstrates, in part, a principle of a flash layer incorporation in these designs. In this particular case, the 50 Å silica layer does not contribute substantially to the design when compared to the fourth example, nor does it detract from it greatly. The insertion of such layers would not, in the opinion of the inventors, circumvent any claims that might depend on the number of layers or the relative refractive indices of layer sets. Flash layers have been shown to impart substantial advantages when used over layer 178 and are discussed above. It is also believed that such flash layers could have adhesion promotion or corrosion resistance advantages when positioned between layers 172 and

178 as well as between glass 114 and layer(s) 120, especially when comprised of metal/alloys mentioned above as having such functions in thicker layers.

According to a sixth example of the embodiment shown in Fig. 3E, an electrochromic mirror was modeled having a back plate 114 of glass, a layer 172 including a sublayer of titanium dioxide of approximately 450 Å and a sublayer of ITO of 1600 Å, a layer 178 of silver of 290 Å and a flash layer of 6Au94Ag of approximately 50 Å, an electrochromic fluid/gel layer 125 having a thickness of approximately 140 microns, a layer 128 of approximately 1400 Å of ITO, and a glass plate 112 of 2.1 mm. In air, on glass 114, the model of the conductive thin film 120 for this example, using D65 illuminant at 20 degree angle of incidence, exhibited values of approximately $Y=81.3$, $a^*=-3.26$, and $b^*=4.16$. This model also indicated a relative transmittance peak at about 600 nm of about 17 percent. When this back plate system 114, 120 is incorporated into an electrochromic mirror, the predicted overall reflectance decreases and the transmittance increases. As one compares this stack to the fourth example, it illustrates, in part, the principle of using a flash layer of a silver alloy over silver. The potential advantages of such a system for layer 178, as opposed to a single alloy layer per the fourth example, include, but are not limited to, reduced cost, increased reflectivity at the same transmission or increased transmissivity at the same reflectance, decreased sheet resistance, and the possibility of using a higher percentage of alloyed material in the flash overcoat layer to maintain enhanced electrode surface properties the silver alloy exhibits over pure silver. Similar potential advantages apply to the cases of different percentage alloys or a graded percentage alloy in layer 178.

According to a seventh example of the embodiment shown in Fig. 3E, an electrochromic mirror was modeled having a back plate 114 of glass, a layer 172 of silicon of approximately 180 Å, a layer 178 of 6Au94Ag of approximately 410 Å, an electrochromic fluid/gel layer 125 having a thickness of approximately 140 microns, a layer 128 of approximately 1400 Å of ITO, a glass plate 112 of 2.1 mm. In air, on glass 114, the model of the conductive thin film 120 for this example, using D65 illuminant at 20 degree angle of incidence, exhibited values of $Y=80.4$, $a^*=0.9$, and $b^*=-3.39$. In contrast, a thin layer of 6Au94Ag on glass with similar reflectivity exhibits a yellow hue in reflection. The model also indicated a spectrally dependent transmittance that reached a peak of about 18 percent at 580 nm. When this back plate system 114, 120 is

incorporated into an electrochromic mirror, the predicted overall reflectance and the transmittance increases. In this case, the values would be appropriate for an automotive interior transflective mirror. This system would be especially useful if the silicon were deposited as a semi-conductive material, thereby allowing for masking of the silver alloy layer so that the silver alloy would be deposited primarily in the viewing area while still maintaining conductivity to the area to be darkened.

According to an eighth example of the embodiment shown in Fig. 3E, an electrochromic rearview mirror was modeled having a back plate 114 of glass, a layer 172 including a sublayer of silicon of approximately 111 Å and a sublayer of ITO of approximately 200 Å, a layer 178 of 6Au94Ag of approximately 340 Å, an electrochromic fluid/gel layer 125 having a thickness of approximately 140 microns, a layer 128 of approximately 1400 Å of ITO, and a glass plate 112 of 2.1 mm. In air, on glass 114, the model of the conductive thin film 120 for this example using D65 illuminant at 20 degree angle of incidence exhibited values of approximately Y=80.7, a^*=0.1, and b^*=-1.7. The model also indicated a spectrally dependent transmittance that reached a peak at about 18 percent at 600 nm. When this back plate system 114, 120 is incorporated into an electrochromic mirror, the predicted overall reflectance decreases and the transmittance increases. In this case, the values would be appropriate for an automotive transflective mirror. Also in this case, masking of the silver alloy layer could take place in the seal area, and the conductivity of the back electrode of the system would be maintained by the ITO layer whether or not the silicon were semi-conductive. This example is advantageous in that it utilizes thin layers, which are easier to form during high volume manufacturing.

According to a ninth example of the embodiment shown in Fig. 3E, an electrochromic mirror was modeled having a back plate 114 of glass, a layer 172 including a sublayer of silicon of approximately 77 Å and a sublayer of ITO of approximately 200 Å, a layer 178 of 6Au94Ag of approximately 181 Å, an electrochromic fluid/gel layer 125 having a thickness of approximately 140 microns, a layer 128 of approximately 1400 Å of ITO, and a glass plate 112 of 2.1 mm. In air, on glass, the model of the conductive thin film 120 for this example, using D65 illuminant at 20 degree angle of incidence, exhibited values of approximately Y=64.98, a^*=1.73, and b^*=-2.69. The model also indicated a spectrally dependent transmittance that

reached a peak of about 35 percent at 650 nm. When this back plate system is incorporated into an electrochromic mirror, the predicted overall reflectance decreases and the transmittance increases. In this case, the values would be appropriate for an automotive exterior transflective mirror.

According to a tenth example of the embodiment shown in Fig. 3E, an electrochromic mirror was modeled having a back plate 114 of glass, a layer 172 of fluorine-doped tin oxide of approximately 1957 Å (3/4 wave optima thickness), a layer 178 of 6Au94Ag of approximately 350 Å, an electrochromic fluid/gel layer 125 having a thickness of approximately 140 microns, a layer 128 of approximately 1400 Å of ITO, and a glass plate 112 of 2.1 mm. In air, on glass 114, the model of the conductive thin film 120, for this example, using D65 Illuminant at 20 degree angle of incidence, exhibited outputs of approximately Y=80.38, a^*=1.04, and b^*=5.6. The model also indicated a spectrally dependent transmittance that overall diminished as wavelength increased in the visible range. Transmittance at 630 nm was predicted as approximately 10 percent. When this back plate system is incorporated into an electrochromic mirror, the predicted overall reflectance decreases and the transmittance increases. In this case, the values would be appropriate for an automotive interior transflective mirror.

In a mirror construction, such as that shown in Fig. 3E, the mirror preferably exhibits a reflectivity of at least 35 percent, more preferably at least 50 percent, and more preferably at least 65 percent for an outside mirror and, for an inside mirror, the mirror preferably exhibits a reflectance of at least 70 percent and more preferably at least 80 percent. To obtain such reflectance levels, the reflective second electrode 120 should have a slightly higher reflectance. The mirror preferably exhibits a transmittance of at least about 5 percent, more preferably at least about 10 percent, and most preferably at least about 15 percent. To obtain these transmittance levels, the second electrode 120 may have a slightly lower transmittance.

Because electrochromic mirrors having a b* value of greater than +15 have an objectionable yellowish hue, it is preferable that the mirror exhibits a b* value less than about 15, and more preferably less than about 10. Thus, second electrode 120 preferably exhibits similar properties.

To obtain an electrochromic mirror having relative color neutrality, the C* value of the mirror should be less than 20. Preferably, the C* value is less than 15, and more

preferably is less than about 10. Second electrode 120 preferably exhibits similar C* values.

The inventors have recognized that, when a thin layer of silver or silver alloy is used in a rearview mirror such as those described above, the thin layer may impart a light yellow hue (b* greater than +15) to objects viewed in the reflection particularly when the thin layer of silver or silver alloy is made thin enough to impart sufficient transmittance of 5 percent or more. This causes the mirror to no longer appear color neutral (C* greater than 20). Cooversely, transmission through the film is higher for blue light than for red light. The teo preceding examples compensate for this liability by selection of the appropriate thicknesses of various underlayer films. Another approach to minimizing the yellow hue of the reflected images is to reflect the transmitted blue light back through the mirror. Typically, in the prior art signal or display mirrors a coating of black paint is applied to the fourth surface of the mirror in all areas except for where a display is mounted (if one is employed). Such a black coating was designed to absorb any light that is transmitted through the mirror and its reflective layer(s). To minimize the yellow hue of the reflected image appearing when a thin silver/silver alloy material is used, the black coating may be replaced with a coating 182 that reflects the blue light back through the mirror rather than absorbing such blue light. Preferably, blue paint is used in place of the black paint since the blue backing reflects blue light. Alternatively, coating 182 may be white, gray, or a reflective coating such as chrome, since they too would reflect blue light back through the reflective layer(s) and the remainder of the mirror.

To demonstrate the effectiveness of blue coating 182 on the fourth surface 114b of a mirror, an electrochromic mirror was constructed with a thin layer of silver 178 over a 100 Ω/□ ITO layer 172 as the third surface reflector/electrode 120. The white light reflectivity of the mirror was about 52 percent, and the white light transmission was about 30 percent. The mirror had a noticeably yellow hue in reflection and a blue hue in transmission. The mirror was placed on a black background and the color was measured using a SP-68 Spectrophotometer from X-Rite, Inc. of Grandville, Michigan. The measured b* value was +18.72. The same mirror was then placed on a blue background and the color was again measured. With the blue background, the measured

b* value fell to +7.55. The mirror thus exhibited noticeably less yellow hue in reflection on the blue background as compared to a black background.

Yet another variation of reflector/electrode 120 is illustrated in Fig. 3F. As illustrated, reflector/electrode 120 is constructed across substantially the eotire front surface 114a of rear element 114 with an electrically conductive multi-layer interferential thin-film coating 190. Conductive thin-film coating 190 is preferably tailored to maximize transmittance to light having wavelengths within a narrow band corresponding to the wavelength of light emitted from light source 170. Thus, if light source 170 were a signal light including red, red-orange, or amber AlGaAs or AlInGaP LEDs, the light emitted from such LEDs would have wavelengths in the range of 585 nm to 660 nm, and conductive thin-film coating 190 would be tailored to maximize spectral transmittance at those wavelengths. By increasing the transmittaoce preferentially within this relatively narrow band of wavelengths, the average luminous reflectance to white light remains relatively high. As will be apparent from the four examples provided below of electrodes constructed using such conductive thin-film coatings, the conductive thin-film coating as so constructed includes a first layer 184 of a first material having a relatively high refractive index, a second layer 186 of a second material formed on first layer 184 where the second material has a relatively low refractive index, and a third layer 187 formed on second layer 186 and made of a material that has a relatively high refractive index. Conductive thin-film coating 190 may also include a thin fourth layer 188 of an electrically conductive material formed on third layer 187. If third layer 187 is not electrically conductive, fourth layer 188 of an electrically conductive material must be disposed on third layer 187. If the first, second, and third layers provide sufficient reflectivity, such a fourth layer 188 may be made of a transparent conductive material. If not, fourth layer 188 may be made of a reflective material.

Conductive thin-film coating 190 preferably exhibits: a luminous reflectance of 35 to 95 percent, a reflected C* value of 20 or less, a signal light/display luminous transmittance of 10 percent or more, and a sheet resistance of less than 100 Ω/□. More preferably, C* is less than 15 and most preferably less thao 10, and the value of a* is negative. As a measure of comparison, luminous reflection and reflected C* for this coating may be measured using one or more of the CIE illuminants A, B, C, or D55, D65, an equal-energy white source or other broad-band source meeting the SAE

definition of white. Luminous reflectance and reflected C* for this coating may be measured at one or more angles of incidence between 10° and 45° from the surface normal. The signal light/display luminous transmittance for this coating may be measured using one or more signal or display sources such as amber, orange, red-orange, red, or deep red LEDs, vacuum fluorescent displays (VFDs), or other lamps or displays, and at one or more angles of incidence between 20° and 55° from the surface normal. As will be apparent to those skilled in the art, "Luminous Reflectance" and "Signal light/display Luminous Transmittance" imply use of either or both of the 1931 CIE 2 degree observer V_λ or V_λ' as the eye-weighting functions.

By configuring conductive thin-film coating 190 to have a reflectance, transmittance, electrical conductivity, and a reflected C* value within the above parameters, an electrode may thus be constructed that has medium to high reflectance, substantially neutral reflectance for faithful rendering, medium to high in-band signal light/display transmittance for efficiency and brightness, and low sheet resistance for good electrochromic functionality.

In the specific examples of such a conductive thin-film coating, the first and third materials forming first and third layers 184 and 187, respectively, may be the same or a different material selected from the group consisting essentially of indium tin oxide, fluorine-doped tin oxide, titanium dioxide, tin dioxide, tantalum pentoxide, zinc oxide, zirconium oxide, iron oxide, silicon, or any other material having a relatively high refractive index. Second layer 186 may be made of silicon dioxide, niobium oxide, magnesium fluoride, aluminum oxide, or any other material having a low refractive index. First layer 184 may have a thickness of between about 200 Å to 800 Å, second layer 186 may have a thickness of between about 400 Å to 1200 Å, third layer 187 may have a thickness between about 600 Å to 1400 Å, and layer 188 may have a thickness of about 150 Å to 300 Å. Other optima thicknesses outside these ranges may also be obtainable per the above description. Inserting additional layer sets of low and high index materials can raise reflectance further. Preferably, the electrically conductive material forming fourth layer 188 is made of a reflective material such as silver or silver alloy, or of a transparent conductive material such as ITO.

According to a first example of conductive thin-film coating 190, an electrochromic mirror was modeled having a front element 112 having a thickness of 2.2

mm, a first electrode 128 made of ITO and having a thickness of approximately 1400 Å, an electrochromic fluid/gel having a thickness of approximately 137 to 190 microns, and a conductive thin-film coating 190 provided on a rear glass substrate 114. Conductive thin-film coating 190 in this first example included a first layer 184 made of ITO and having a thickness of approximately 750 Å, a second layer 186 made of SiO_2 and having a thickness of approximately 940 Å, a third layer 187 made of ITO and having a thickness of approximately 845 Å, and a fourth layer 188 made of silver and having a thickness of 275 Å. In air, the conductive thin-film coating 190 modeled in this first example exhibited a luminous reflectance of approximately 80.2 percent for white light and a spectral transmittance of approximately 22.5 percent on average for light having wavelengths between 620 nm and 650 nm. Such characteristics make the conductive thin-film coating 190 according to this first example suitable for use either in an inside or outside rearview mirror. When this conductive thin-film coating is applied to the front surface of rear glass element and incorporated into an electrochromic mirror, the overall reflectance decreases and the transmittance increases.

According to a second example, another electrochromic mirror was modeled having the same features as discussed above with the exception that conductive thin-film coating 190 included a first layer 184 made of ITO and having a thickness of approximately 525 Å, a second layer of SiO_2 having a thickness of approximately 890 Å, a third layer 187 made of ITO and having a thickness of approximately 944 Å, and a fourth layer 188 made of silver and having a thickness of approximately 168 Å. In air, the conductive thin-film coating as constructed in the second example has a luminous reflectance of approximately 63 percent for white light incident thereupon at a 20° angle of incidence, and a spectral transmittance of approximately 41 percent on average for light having wavelengths in the 620 nm to 650 nm wavelength range at 20° angle of incidence. Such a conductive thin-film coating 190 is particularly suitable for an outside rearview mirror. When this conductive thin-film coating is applied to the front surface of rear glass element and incorporated into an electrochromic mirror, the overall reflectance decreases and the transmittance increases.

A conductive thin-film coating according to a third example was modeled that was made of the same materials as described for the first two conductive thin-film coatings except that first layer 184 had a thickness of approximately 525 Å, second layer

186 had a thickness of approximately 890 Å, third layer 187 had a thickness of approximately 945 Å, and fourth layer 188 had a thickness of approximately 170 Å. In air, the conductive thin-film coating thus modeled had a luminous reflectance of 63 percent at 20° angle of incidence for illumination with white light, and an average spectral transmittance of approximately 41 percent for light having wavelengths between the 620 nm and 650 nm wavelength range at 20° angle of ineidence. When this conductive thin-film coating is applied to the front surface of rear glass element and incorporated into an electrochromic mirror, the overall reflectance decreases and the transmittance increases.

According to a fourth example, a non-conductive three layer interference coating available from Libbey Owens Ford (LOF) of Toledo, Ohio, is used in combination with a conductive fourth layer 188 of ITO or the like. The thin film stack available from LOF has a first layer 184 of Si, a second layer 186 of SiO_2, and a third layer 187 of SnO_2. This coating has a reflectance of approximately 80 percent and a transmittance of approximately 4 percent for white light, and transmittance of 7 to 10 percent for light having wavelengths in the 650 to 700 nm range. The transmittance in the 650 to 700 nm range makes this thin film stack particularly suitable for a signal mirror that utilizes a red light source. While the SnO_2, SiO_2 and Si used in the LOF thin film stack are not highly reflective materials by themselves (particularly when applied as a thin layer), the alternating layers of such materials having high and low refractive indices produce the requisite high level of reflectivity. The poor electrical conductivity of this thin film stack requires that it be implemented with an electrically conductive layer that has good electrical conductivity, such as a layer of ITO or the like. The LOF thin film stack overcoated with an ITO layer having a half-wave thickness exhibited a sheet resistance of 12 Ω/□. When the ITO/LOF thin-film stack was used as a second electrode for an electrochromic mirror, the mirror had a reflectance of 65 percent. Several different displays were placed behind the assembled mirror and were all easily observed.

Fig. 3G shows yet another alternate construction that is very similar to that shown in Fig. 3F, with the exception that only three layers are utilized for the electrically conductive multi-layer thin-film coating 190. According to the construction shown in Fig. 3G, thin-film coating 190 includes a first layer 184 made of a material having a high refractive index such as the materials noted above in connection with Fig.

3F, a second layer made of a material having a low refractive index such as those materials also discussed above for layer 186 in Fig. 3F, and a third layer 188 of electrically conductive material. Layer 188 need not be made of a material having a high refractive index, but rather may be made of any electrically conductive material suitable for use in an electrochromic mirror. For example, layer 188 may be a highly reflective metal, such as silver or a silver alloy, or may be a metal oxide, such as ITO. To illustrate the feasibility of such a coating, two examples are described below.

In a first example, an electrochromic mirror was modeled having a first layer 184 of ITO deposited on a front surface of rear glass substrate 114 at a thickness of 590 Å, a second layer 186 of silicon dioxide applied at a thickness of 324 Å over first layer 184, and a third layer 188 of silver having a thickness of 160 Å applied over second layer 186. The electrochromic mirror was then illuminated with a CIE illuminant D65 white light source at an angle of incidence of 20°. When illuminated with such white light, the mirror exhibited a luminance reflectance of 52 percent and a* and b* values of approximately 1.0 and 5.0, respectively. When illuminated with a red LED source at 35° angle of incidence, the mirror exhibited a luminous transmittance of 40 percent.

According to a second example of the structure shown in Fig. 3G, an electrochromic mirror was modeled having a first layer 184 of silicon deposited at a thickness of 184 Å on the front surface of glass substrate 114, a second layer 186 deposited on first layer 184 and formed of silicon dioxide at a thickness of 1147 Å, and a third layer 188 of ITO of a thickness of 1076 Å applied over second layer 186. The electrochromic mirror having such a coating was illuminated with a CIE illuminant D65 white light source at 20° angle of incidence. When modeled as illuminated with such white light, the modeled mirror exhibited a luminous reflectance of 54 percent and a* and b* values of -2.5 and 3.0, respectively. When modeled as illuminated with a red LED source at 35° angle of incidence, the modeled mirror exhibited a luminous transmittance of approximately 40 percent.

Considering that the above two three-layer examples exhibited luminous reflectance in excess of 50 percent and transmittance of approximately 40 percent, a mirror constructed as shown in Fig. 3G meets the specific objectives noted above with respect to Fig. 3F, and is therefore suitable for use in an outside electrochromic rearview mirror incorporating a signal light.

As will be apparent to those skilled in the art, the electrically conductive multi-layer thin-film coating described above may be implemented as a third surface reflector for an electrochromic mirror regardless of whether the electrochromic medium is a solution-pbase, gel-phase, or hybrid (solid state/solution or solid state/gel).

Although the above alternative constructions shown and described with respect to Figs. 3A-3G do not include a flash-over protective layer, those skilled in the art will understand that such a flasb-over layer may be applied over any of the various reflector/electrode 120 constructions showo in Figs. 3A-3G.

Fig. 4 shows a cross section of one embodiment of the present invention as similarly illustrated in Fig. 3E above. Specifically, by mounting a light emitting display assembly, indicator, enunciator, or other graphics 170 behind a reflective layer such as layer 178, spurious reflections occur at various interfaces within the electrochromic mirror that result in one or more ghost images being readily viewable by the vehicle occupants. The perceived separatlon between these images increases as the reflective surfaces move further apart. In general, the thinner the glass used in the mirror construction, the less objectionable the images become. However, eliminating or reducing the intensity of the spurious reflections enhances the overall clarity of the display. As sbown in Fig. 4, a point of illumination from display 170 emits light through element 114 as illustrated by light rays A and B, which are only two of an infinite number of light rays that could bc traced from any one point source. Light rays A and B are then transmitted through transparent conductive layer 172 with little or no reflections at the ioterface betweeo electrode 172 and element 114 due to the closeness of the indices of refraction of tbese two components. The light then reaches the interface between transparent layer 172 and reflective layer 178, where between 10 and 20 percent of the light is transmitted through reflective layer 178 into electrochromic medium 125. A large percentage of the light intensity striking reflective layer 178 is thus reflected back as illustrated by light rays C and D. While reflected light that is incident upon a paint layer 182 on rear surface 114b of element 114 (ray C) may be absorbed substantially in its entirety, light that is reflected back at display 170 (ray D) is not absorbed by the layer of absorbent paint 182. Because many light emitting displays, such as a vacuum fluorescent display with a glass top plate, an LCD, or any other display assembly mounted such that there is an air gap between surface 114b and the

front surface of display 170, typically include at least one specular surface 171, light reflected back at the specular surface(s) 171 of display 170 (ray D) is reflected off surface 171 back through element 114, reflective electrode 120, clectrochromic medium 125, layers 128 and 130, and element 112. This spurious reflection off of the specular surface 171 of display 170 thus creates a ghost image that is viewable by the vehicle occupants. Additional spurious reflections occur at the outer surface 112a of element 112 due to the differences in refractive indices of element 112 and the air surrounding the electrochromic mirror. Thus, light represented by ray F is reflected back into the mirror from surface 112a and is subsequently reflected off of reflective layer 178 back though medium 125, layers 128 and 130, and element 112. It is therefore desirable to implement various measures that eliminate or reduce the intensity of these spurious reflections and thereby eliminate the annoying ghost images that are visible to the vehicle occupants. Figs. 5A-5D, which are described below, illustrate various modifications that may be made to reduce these spurious reflections. It should be noted that these spurious reflections are always lower in brigbtness than the nonreflected image. One approach to improving the clarity of the display without eliminating spurious reflections is to control the display brightness such that the intensity of the secondary images are below the visual perception threshold. This brightness level will vary with ambient light levels. The ambient light levels can be accurately determined by photosensors in the mirror. This feedback can be used to adjust the display brightness so the secondary images are not bright enough to be objectionable.

In the embodiment shown in Fig. 5A, means 192 and 194 are provided for reducing or preventing reflections from specular surface 171 and front surface 112a of element 112, respectively. Anti-reflective means 192 may include an anti-reflective film applied to the rear surface 114b of element 114 or to any and all specularly reflecting surfaces of display assembly 170. Anti-reflective means 192 may also include a light absorbing mask applied to rear surface 114b or specular surface 171 of display assembly 170. Such a masking layer 192 may be made to cover substantially the entirety of specular surface 171, with the exception of those regions lying directly over a light emitting segment of display 170. The masking may be made with any light absorbing material, such as black paint, black tape, black foam backing, or the like. It should be noted that vacuum florescent displays are available with an internal black mask in all

areas around the individual light emitting elements. If anti-reflective means 192 is formed as an anti-reflective layer, substantially any known anti-reflective film may be employed for this purpose. The anti-reflective film need only be constructed to prevent reflections at the particular wavelength of the light emitted from display 170.

By providing anti-reflective means 192 as described above, any light that is reflected back from reflective layer 178 toward specular surface 171 of display 170 is either absorbed or transmitted into display 170, such that it cannot be reflected from surface 171 through the device towards the eyes of the vehicle occupants. It should be noted that anti-reflective means 192 may also include any other structure capable of reducing or preventing the reflection of light from specular surface 171. Further, anti-reflective means 192 may include a combination of an anti-reflective film and a masking layer and layer 192 may be incorporated on any specularly reflective surface that could reflect light reflected off reflector 178, for example, either the back surface of glass element 114, the front surface of display 170, or any internal surface in display 170.

To reduce the spurious reflections from the air interface with surface 112a of element 112, an anti-reflective film 194 may be provided on surface 112a. Anti-reflective film 194 may be formed of any conventional structure. A circular polarizer inserted between the transflective coating and the display is also useful in reducing spurious reflections.

Fig. 5B shows an alternative solution to the problems relating to the reflection of light from display 170 off of reflective layer 178 and the specular surface of the display. Specifically, display 170 is preferably selected from those displays that do not include any form of specular surface. Examples of such displays are available from Hewlett Packard and are referenced as the HDSP Series. Such displays generally have a front surface that is substantially light absorbing, such that little if any light would be reflected off the forward-facing surface of the display.

Another example of a display construction that would not have a specularly reflecting surface (such as between glass and air) would be a back lit liquid crystal display (LCD) that is laminated directly onto the back mirror surface 114b to eliminate the air gap or air interface between the display and the mirror. Eliminating the air gap is an effective means of minimizing the first surface reflection of all display devices. If the

type of LCD used was normally opaque or dark such as with a twisted nematic LCD with parallel polarizers or a phase change or guest host LCD with a black dye, the reflected light would be absorbed by the display and not re-reflected back toward the viewer. Another approach would be to use a back lit transmissive twisted nematic LCD with crossed polarizers. The entire display area would then be illuminated and contrasted with black digits. Alternatively, a positive or negative contrast electrochromic display could be used in place of the LCD, or an organic LED could be laminated or fixed to the back surface 114b.

An alternative solution is shown in Fig. 5C, whereby display 170 is mounted in back of rear surface 114b of rear element 114, such that specular surface 171 is inclined at an angle to rear surface 114b. As apparent from the ray tracings in Fig. 5C, any light emitted from display 170 that reflects off of reflective layer 178 back toward specular surface 171 of display 170 is reflected off of specular surface 171 at an angle which could direct the light beam away from the viewer towards, for instance, the roof of the vehicle or, if the angle of the display is great enough, the beam could be directed toward an absorbing surface such as a black mask applied to the back of the mirror on surface 114b. It should be noted that, rather than angling the display, the reflected beam could be deflected by some other means such as by laminating a transparent wedge shape on the front of the display, the goal being to redirect the reflected light out of the viewing cone of the display or to an absorbing media or surface.

As shown in Fig. 5E, another useful technique to reduce spurious reflections is to reflect the display image off of a mirror surface 197 (preferably a first surface mirror) at about a 45° angle and then through the transflective layer 120. The image reflected off the transflective layer 120 can then be redirected away from the specular surfaces on the display by slightly angling the relationship of the display to the transflective layer.

Fig. 5D shows yet another approach for overcoming the problems noted above. Specifically, the embodiment shown in Fig. 5D overcomes the problem by actually mounting the display in front of reflective layer 178. To enable the display to be mounted in front of the reflected layer, a substantially transparent display, such as an organic light emitting diode (OLED) 196 is utilized. OLEDs are available from Universal Display Corporation. Such OLEDs can be constructed such that they are thin

transparent displays that could be mounted inside the chamber in wbich the electrochromic medium is maintained. Because OLED 196 can be transparent, it would not interfere with the image viewed by the driver of the vehicle. Additionally, by providing OLED 196 inside the chamber between the substrates, display 196 is protected from any adverse environmental effects. Thus, such an arrangement is particularly desirable when mounting a display device in an exterior automotive rearview mirror. OLED 196 could be mounted on layer 178, layer 128, between layers 128 and 130, between layer 130 and element 112, between layers 172 and 178, between layer 172 and element 114, to rear surface 114b of element 114, or to surface 112a of element 112. Preferably, OLED display 196 is mounted in front of reflective layer 178 in the chamber between elements 112 and 114.

To take advantage of the fact that the reflective layer in an electrochromic mirror may be partially transmissive over its entire surface area, a light collector may be employed behind the reflective layer to collect the light impinging on the mirror over a much larger area than previously possible and to amplify the light as it is directed onto a photosensor. As will be described in more detail below, the use of such a light collector more than compensates for the lack of the provision of an opening in the reflective layer and actually can increase the sensitivity of the glare sensor in an electrochromic mirror.

Fig. 6 is a front view of an inside rearview mirror constructed in accordance with the present invention. Fig. 7 is a cross-sectional view taken along plane 7-7' of Fig. 6. According to this construction, the light collector may be constructed as a plano-convex lens 609 mounted behind a partially transmissive reflecting surface 607 and a variable attenuating layer 608. As shown in Fig. 7, lens 609 projects light from source 601 onto focal point 604 and ligbt from source 601a onto focal point 604a. A small area sensor, for example, the single pixel sensor of U.S. Patent Application No. 09/237,107, filed on January 25, 1999, is provided to sense glare from the rear viewed through lens 609, partially transmissive layer 607, and optionally through variable attenuating layer 608. This construction takes advantage of the fact that the active sensing area of sensor 605 is small, for example, 100 microns on a side, and that a relatively large light collector, lens 609 in this example, can be substantially hidden behind the partially transmissive mirror and configured so that relatively high optical gain may be provided for the sensor while still providing a characterized and relatively large field of view over whicb glare is

sensed. In the example shown in Fig. 7, light source 601a is approximately 20 degrees off of the central axis and is close to the edge of the amplified field of view. Note that unamplified light, part of whicb may not pass through the lens, may be used to maintain some sensitivity to glarc over a larger field of view.

When designing a construction such as those shown in Figs. 6 and 7, there are several design considerations. Because the source of light that impinges upon the mirror and creates glare is the head lamps of automobiles to the rear of the vehicle, and such light sources are at a great distance away from the mirror relative to the size of the lens, the rays from an automotive bead lamp light source are substantially parallel. With a good lens, most of the rays impinging on the lens from a source are projected to a relatively small, intense spot at the focal point 604. For a sensing position other than at the focal point, as a first approximation, the optical gain is the ratio of the area of the lens through which light enters to that of the cross section of the focussed cone in the plane where the ligbt is sensed. In Fig. 7, witb a spherical or aspherical lens 609, this would be the square of the ratio at the diameter of lens 609 to the length of line 610. This is approximately 10 as depicted. If sensor 605 was placed at the focal point 604 as it would be if it were a pixel in an imaging array, nearly all of the light passing through the lens from light source 601 would strike sensor 605, making the optical gain very high. However, ligbt from a light source 601a would totally miss the sensor and the field of view would be extremely small. In Fig. 7, sensor 605 is placed at a highly de-focussed point, which is common to the cones of light from light sources having positions for wbich optical gain should be maintained. Note that the plane can optionally be chosen beyond the focal point or other methods of diffusion may be used alone or in combination to widen and characterize the field of view. For a substantially greater off-axis angle, the sensor will be outside of the projected cone of light and no optical gain will be provided. Note that to provide relatively high optical gain over a substantial field of view, the collecting area should be quite large compared to the sensor. The area of the aperture should exceed the area of the sensor first by approximately the ratio of the optical gain, and this ratio should be multiplied by another large factor to provide a field of view having a solid angle that is much larger than that which would be imaged onto the sensor were it to be placed in the focal plane of the lens.

While this particular mirror construction has been described above as including a spberical or an aspberical lens 609, a Fresnel lens may replace the plano-convex lens depicted. Additionally, since for large fields of views the light rays must be redirected through even larger angles, totally internally reflecting (TIR) lenses or reflectors may be used and provide additional advantages. If, for example, a partially transmissive reflecting layer 607 with 20 percent transmission is chosen and an optical gain of 10 is used, tbe optical gain more than recovers the loss incurred in passing through partially transmissive reflector 607. Furthermore, no unsightly or expensive-to-produce aperture window needs to be provided for the sensor and control benefits of viewing through the layer are also realized.

In configurations where the viewing angle needs to be large in one direction but relatively small in another, a cylindrical lens may be used. For example, to sense lights from vehicles in adjacent lanes, the viewing angle must be relatively large in the horizontal direction and the viewing field may be relatively narrow in the vertical direction. In this case, lens 609 may be replaced by a cylindrical lens with a horizontal axis. A stripe of light rather than a circle is projected, and since light gathering takes place in one rather than two directions, the benefit of the squaring effect for the relative areas of the lens aperture in the area of the projected light pattern in the plane of the sensor is lost. Optical gains of 5, for example, are still feasible, however. Composite lenses containing a patchwork of different elements including, for example, sections of aspberic lenses with different center positions and/or focal lengtbs, or even combinations of different kinds of elements such as aspheric and cylindrical lenses may be used to retain reasonable optical gain and characterize the field of view. A row of lens sections with stepped focal center points can serve well to widen the field of view in selected directions while maintaining a good overall optical gain. Some amount of diffusion is preferable in all the designs to prevent severe irregularity in the sensed light level due to severe localized irregularities in the projected light pattern that are often present. The extremely small area sensor will not average these irregularities to any useful degree. Some lens designs may optionally be cemented to the back of the mirror element.

In each of the constructions described above witb respect to Figs. 6 and 7, any of the mirror constructions described above witb respect to Figs. 3A-3G may be employed for use as the electrochromic mirror (depicted as layers 607 and 608 in Fig. 7).

Fig. 8 shows an outside rearview mirror assembly 200 constructed in accordance with another embodiment of the present invention. Outside rearview mirror assembly 200 includes a mirror 210, which is preferably an electrochromic mirror, an external mirror housing 212 having a mounting portion 214 for mounting mirror assembly 200 to the exterior of a vehicle, and a signal light 220 mounted bebind mirror 210. To enable the light from signal light 220 to project through electrochromic mirror 210, a plurality of signal light areas 222 are formed in the electrode/reflector of mirror 210 that include window regions containing electrically conductive material that is at least partially transmissive similar to the information display and glare sensor window areas described above with respect to the other embodiments of the present invention. Electrochromic mirror 210 may further include a sensor area 224 disposed within the reflective coating on electrochromic mirror 210 and similarly include window regions containing electrically conductive material that is at least partially transmissive so as to allow some of the incident light to reach a sensor mounted bebind sensor area 224. Alternatively, sensor 224 could be used to sense glare in night driving conditions and control the dimming of the exterior mirror independently or verify that the mirrors are being sufficiently dimmed by the control circuit in the interior mirror. In such a case, a more sensitive photo sensor may be required, such as a CdS sensor.

Signal light 220 is preferably provided to serve as a turn signal light and is thus selectively actuated in response to a control signal generated by a turn signal actuator 226. The control signal is therefore applied to signal light 220 as an intermittent voltage so as to energize signal light 220 when a driver has actuated the turn signal lever. As shown in Fig. 11, when vehicle B is in the blind spot of vehicle A where the driver of vehicle A cannot see vehicle B, the driver of vehicle B cannot see the turn signal on the rear of vehicle A. Thus, if the driver of vehicle A activates the turn signal and attempts to change lanes while vehicle B is in a blind spot, the driver of vehicle B may not receive any advance notice of the impending lane change, and heoce, may not be able to avoid an accident. By providing a turn signal light in an outside rearview mirror assembly 200 of vehicle A, the driver of an approaching vehicle B will be able to see that the driver of vehicle A is about to change lanes and may thus take appropriate action more quickly so as to avoid an accident. As illustrated in Fig. 15 and described in more detail below, the signal light is preferably mounted within mirror assembly at an angle to

the mirror surface to project the light from the signal light outward into the adjacent lanes in the blind spot areas proximate the vehicle.

Referring agaio to Fig. 8, electrochromic mirror 220 may be controlled in a conventional manner by a mirror control circuit 230 provided in the inside rearview mirror assembly. Inside mirror control circuit 230 receives signals from an ambient light sensor 232, which is typically mounted in a forward facing position on the Interior rearview mirror housing. Control circuit 230 also receives a sigoal from a glare sensor 234 mounted in a rearward facing position of the interior rearview mirror assembly. Inside mirror control circuit 230 applies a control voltage on a pair of lines 236 in a conventional manner, such that a variable voltage is applied essentially across the entire surface of electrochromic mirror 210. Thus, by varying the voltage applied to lines 236, cootrol circuit 230 may vary the transmittance of the electrochromic medium in mirror 210 in response to the light levels sensed by ambieot sensor 232 and glare sensor 234. As will be explained further below, an optional third cootrol line 238 may be connected between the inside mirror control circuit 230 and a variable atteouator 260 provided in outside mirror assembly 200, so as to selectively attenuate the energizing signal applied on lines 228 from turn signal actuator 226 to the signal light 220 in response to the control signal sent oo line 238. In this manner, inside mirror control circuit 230 may selectively and remotely control the intensity of signal light 220 based upoo information obtained from sensors 232 and 234 and thereby eliminate the need for a sensor to be mounted in each mirror assembly as well as the associated sensor area 224.

Mirror assembly 200 may further include an electric heater (not shown) provided behind mirror 210 that is selectively actuated by a beater control circuit 240 via lines 242. Such beaters are knowo in the art to be effective for deicing and defogging such external rearview mirrors. Mirror assembly 200 may optionally include a mirror position servomotor (not shown) that is driven by a mirror position cootroller 244 via lines 246. Sucb mirror position servomotors and controls are also knowo in the art. As will be appreciated by those skilled in the art, mirror assembly 200 may include additional features and elements as are now known in the art or may become known in the future without departing from the spirit and scope of the present invention.

An exemplary sigoal light subassembly 220 is sbown in Fig. 9. Such a signal light 220 is disclosed in U.S. Patent Nos. 5,361,190 and 5,788,357, whicb disclose the signal light in combinatioo with dichroic exterior rearview mirrors that are not electrochromic. As explained below, bowever, the same signal light subassembly may be used in connection with an electrochromic mirror as may modified versions of the signal light subassembly shown in Fig. 13.

As shown in Fig. 9, signal light 220 includes a printed circuit board 250 that, in turn, is mounted within a housiog 252 having a peripberal edge that serves as a shroud to block any stray light from exiting the signal light assembly. Signal light 220 preferably includes a plurality of LEDs 254 that are mounted to circuit board 250. LEDs 254 may be mounted in any pattern, but are preferably mounted in a pattern likely to suggest to other vehicle operators that the vehicle having such signal mirrors is about to turn. LEDs 254 may be LEDs that emit red or amber light or any other color light as may prove desirable. LEDs 254 are also preferably mounted to circuit board 250 at an angle away from the direction of the driver. By aogling LEDs relative to mirror 210, the light projected from LEDs 254 may be projected outward away from the driver towards the area C in whicb the driver of another vehicle would be more likely to notice the signal light, as shown in Fig. 11. Heoce, the potential glare from the signal light as viewed by the driver may be effectively reduced.

Signal light 220 may optionally include a day/night seosor 256 also mounted to circuit board 250. If seosor 256 is mounted on circuit board 250, a shroud 257 is also preferably mounted to shield sensor 256 from the light generated by LEDs 254. Also, if sensor 256 is provided in signal light 220, a day/night sensing circuit 258 may also be mounted on circuit board 250 so as to vary the intensity of LEDs 254 io response to the detection of the presence or absence of daylight by sensor 256. Thus, if sensor 256 detects daylight, circuit 258 increases the intensity of the light emitted from LEDs 254 to their highest level and decreases the intensity of the emitted light when sensor 256 detects that it is nighttime. The above-noted signal light disclosed in U.S. Patent Nos. 5,361,190 and 5,788,357 includes such a day/night sensor 256 and associated control circuit 258, and therefore, further description of the operation of the signal light in this regard will not be provided.

As an alternative to providing a day/night sensor 256 in each of the vehicle's exterior rearview mirrors, a variable attenuator 260 or other similar circuit may be provided to vary the driving voltage applied from the turn signal actuator 226 on line 228 in response to a control signal delivered from inside mirror control circuit 230 on a dedicated line 238. In this manner, inside mirror control circuit 230 may utilize the information provided from ambient light sensor 232 as well as the information from glare sensor 234 to control the intensity of the light emitted from LEDs 254 and signal light 220. Since the ambient light and glare sensors 232 and 234 are already provided in an internal electrochromic rearview mirror, providing for such remote control by the inside mirror control circuit 230 eliminates the need for providing additional expensive sensors 256 in the signal light 220 of each exterior mirror assembly. As an alternative to running a separate wire 258 to each of the outside rearview mirrors, variable attenuator 260 may be provided in the dashboard proximate the turn signal actuator or otherwise built into the turn signal actuator, such that a single control line 238′ may be wired from inside mirror control circuit 230 to the turn signal actuator as shown in Fig. 8.

The intensity of the light emitted from the LEDs may thus be varied as a function of the light level sensed by ambient sensor 232 or glare sensor 234, or as a function of the light levels sensed by both sensors 232 and 234. Preferably, LEDs 254 are controlled to be at their greatest intensity when ambient sensor 232 detects daylight and at a lesser intensity when sensor 232 detects no daylight. Because the transmittance of the electrochromic medium is decreased when excessive glare is detected using glare detector 234, the intensity of LEDs 254 is preferably correspondingly increased so as to maintain a relatively constant intensity at nighttime.

Electrochromic mirror 210 may be constructed in accordance with any of the alternative arrangements disclosed in Figs. 3A-3F above, where light source 170 represents one of LEDs 254 of signal light subassembly 220. Accordingly, each possible combination of the various constructions shown in Figs. 3A-3F with signal light subassembly 220 are not illustrated or described in further detail. As but one example, however, Fig. 14 shows the manner in which a signal light subassembly 220 could be mounted behind a preferred construction that is otherwise identical to that shown in Fig. 3C. As apparent from a comparison of Fig. 3C and Fig. 10, each of signal light areas

222 corresponds to window 146 of Fig. 3C. As discussed above, for an outside rearview mirror the reflectance of reflector/electrode 120 is preferably at least 35 percent and the transmittance is preferably at least 20 percent so as to meet the minimum reflectance requirements and yet allow sufficient transmittance so that the light emitted from signal light 220 may be readily noticed by the driver of an approaching vehicle.

Fig. 12 shows a front elevational view schematically illustrating an inside mirror assembly 310 according to an alternative embodimeot of the present invention. Inside mirror assembly 310 may incorporate light-sensing electronic circuitry of the type illustrated and described in the above-referenced Canadian Patent No. 1,300,945, U.S. Patent No. 5,204,778, or U.S. Patent No. 5,451,822, and other circuits capable of sensing glare and ambient light and supplying a drive voltage to the electrochromic element.

Rearview mirrors embodying the present invention preferably include a bezel 344, which conceals and protects the spring clips (not shown) and the peripheral edge portions of the sealing member and both the front and rear glass elements (described in detail below). Wide varieties of bezel designs are well known in the art, such as, for example, the bezel disclosed in above-referenced U.S. Patent No. 5,448,397. There is also a wide variety of known housings for attaching the mirror assembly 310 to the inside front windshield of an automobile; a preferred housing is disclosed in above-referenced U.S. Patent No. 5,337,948.

The electrical circuit preferably incorporates an ambient light sensor (not shown) and a glare light sensor 360, the glare light sensor being capable of sensing glare light and being typically positioned behind the glass elements and looking through a section of the mirror with the reflective material partially removed in accordance with this particular embodiment of the present invention. Alternatively, the glare light sensor can be positioned outside the reflective surfaces, *e.g.*, in the bezel 344. Additionally, an area or areas of the third surface reflective electrode, such as 346, may be partially removed in accordance with the present invention to permit a display, sucb as a compass, clock, or other indicia, to show through to the driver of the vehicle. The present invention is also applicable to a mirror which uses only one video chip light sensor to measure both glare and ambient light and which is further capable of determining the direction of glare. An automatic mirror on the inside of a vehicle,

constructed according to this invention, can also control one or both outside mirrors as slaves in an automatic mirror system.

Fig. 13 shows a cross-sectional view of mirror assembly 310 along the line 13-13' of Fig. 12. Like the above-described embodiments, mirror 310 has a front transparent element 112 having a front surface 112a and a rear surface 112b, and a rear element 114 having a front surface 114a and a rear surface 114b. Since some of the layers of the mirror are very thin, the scale has been distorted for pictorial clarity. A layer of a transparent electrically conductive material 128 is deposited on the second surface 112b to act as an electrode. Transparent conductive material 128 may be any of the materials identified above for the other embodiments. If desired, an optional layer or layers of a color suppression material 130 may be deposited between transparent conductive material 128 and front glass rear surface 112b to suppress the reflection of any unwanted portion of the electromagnetic spectrum.

At least one layer of a material that acts as both a reflector and a conductive electrode 120 is disposed on third surface 114a of mirror 310. Any of the materials/multi-layer films described above may similarly be used for reflector/electrode 120. U.S. Patent No. 5,818,625 describes another reflector/electrode 120 in detail.

In accordance with this embodiment of the present invention, a portion of conductive reflector/electrode 120 is removed to leave an information display area 321 comprised of a non-conducting area 321a (to view a display) and a conducting area 321b (to color and clear the electrochromic medium), as shown in Fig. 13. Although only shown in detail for the display area 321, the same design may be, and preferably is, used for the glare sensor area (160 in Fig. 12). Fig. 14 shows a front elevational view illustrating information display area 321. Again, since some of the layers of this area are very thin, the scales of the figures have been distorted for pictorial clarity. The portion of conductive reflector/electrode that is removed 321a is substantially devoid of conductive material, and the portion not removed should be in electrical contact with the remaining area of reflector/electrode 120. That is to say, there are little or no isolated areas or islands of reflector/electrode 120 that are not electrically connected to the remaining portions of the reflector/electrode 120. Also, although the etched areas 321a are shown as U-shaped (Fig. 13), they may have any shape that allows sufficient current flow through lines 321b while allowing the driver to view and read the display 170

through etched areas 321a. The reflector/electrode 120 may be removed by varying techniques, such as, for example, by etching (laser, chemical, or otherwise), masking during deposition, mechanical scraping, sandblasting, or otherwise. Laser etching is the presently preferred method because of its accuracy, speed, and control.

The information display area 321 is aligned with a display device 170 such as a vacuum fluorescent display, cathode ray tube, liquid crystal, flat panel display and the like, with vacuum fluorescent display being presently preferred. The display 170, having associated control electronics, may exhibit any information helpful to a vehicle occupant, such as a compass, clock, or other indicia, such that the display will show through the removed portion 321a to the vehicle occupant.

The area that is substantially devoid of conductive reflector/electrode 321a and the area having conductive reflector/electrode present 321b may be in any shape or form so long as there is sufficient area having conductive material to allow proper coloring and clearing (*i.e.*, reversibly vary the transmittance) of the electrochromic medium, while at the same time having sufficient area substantially devoid of conductive material to allow proper viewing of the display device 170. As a general rule, information display area 321 should have approximately 70-80 percent of its area substantially devoid of conductive material 321a and the conductive material 321b filling the remaining 20-30 percent. The areas (321a and 321b) may have a variety of patterns such as, for example, linear, circular, elliptical, etc. Also, the demarcation between the reflective regions and the regions devoid of reflective material may be less pronounced by varying the thickness of the reflective materials or by selecting a pattern that has a varying density of reflective material. It is presently preferred that areas 321a and 321b form alternating and contiguous lines (see Fig. 13). By way of example, and not to be construed in any way as limiting the scope of the present invention, the lines 321b generally may be approximately 0.002 inch wide and spaced approximately 0.006 inch apart from one another by the lines substantially devoid of conductive material. It should be understood that although the figures show the lines to be vertical (as viewed by the driver), they may be horizontal or at some angle from vertical. Further, lines 321a need not be straight, although straight vertical lines are presently preferred.

If all of the third surface reflector/electrode 120 is removed in the information display area 321 or in the area aligned with the glare light sensor 160, there will be

significant coloration variations between those areas and the remaining portion of the mirror where the reflector/electrode 120 is not removed. This is because for every electrochromic material oxidized at one electrode there is a corresponding electrochromic material reduced at the other electrode. The oxidation or reduction (depending on the polarity of the electrodes) that occurs on the second surface directly across from the information display area 321 will occur uniformly across the area of the information display area. The corresponding electrochemistry on the third surface will not, however, be uniform. The generation of light-absorbing species will be concentrated at the edges of the information display area (which is devoid of reflector/electrode). Thus, in the information display area 321, the generation of the light-absorbing species at the second surface will be uniformly distributed, whereas the light-absorbing species at the third surface will not, thereby creating aesthetically unappealing color discrepancies to the vehicle occupants. By providing lines of reflector/electrode 120 areas throughout the information display area 321, in accordance with the present invention, the generation of light-absorbing species (at the second and third surfaces) in the information display area will be much closer to the uniformity seen in other areas of the mirror with completely balanced electrodes.

Although those skilled in the art will understand that many modifications may be made, the laser etching may be accomplished by using a 50 watt Nd:YAG laser, such as that made by XCEL Control Laser, located in Orlando, Florida. In addition, those skilled in the art will realize that the power settings, the laser aperture, the mode of the laser (continuous wave or pulsed wave), the speed with which the laser moves across the surface, and the wave form of the laser may be adjusted to suit a particular need. In commercially available lasers there are various wave forms that the laser follows while it ablates the surface coatings. These wave forms include straight lines, sine waves at various frequencies and ramp waves at various frequencies, although many others may be used. In the presently preferred embodiments of the present invention, the areas devoid of reflective material 321a are removed by using the laser in a pulsed wave mode with a frequency of about 3 kHz, having a narrow (*e.g.*, around 0.005 inch) beam width where the laser is moved in a straight line wave form.

Figs. 10B and 10C show two alternate arrangements for implementing the present invention. Figs. 10B and 10C are partial cross-sectional views taken along lines

10-10′ of Fig. 8. Fig. 10B shows an arrangement similar to that of the inside rearview mirror shown in Fig. 13 in which parallel lines of reflector/electrode material 222b are provided across the signal light area 222 by either etching out or masking lines 222a in regions that are devoid of the reflector/electrode material. Each of the signal light areas 222 is provided in a position on the rearview mirror corresponding and overlying one of LEDs 254 as apparent from a comparison of Figs. 8 and 9. Electrochromic mirror 410 may be constructed in the same manner as described above for the inside rearview mirror 310 of the preceding embodiment. Specifically, mirror 410 includes a front transparent element 112 having a front surface and a rear surface, and a rear element 114 having a front surface 114a and a rear surface 114b. Mirror 410 also includes a layer 128 of a transparent conductive material deposited on the rear surface of front element 112 or on an optional color suppression material 130 that is deposited on the rear surface of front element 112. Additionally, mirror 410 includes at least one layer 120 disposed on a front surface 114a of rear element 314 that acts as both a reflector and a conductive electrode. An electrochromic medium is disposed in a chamber defined between layers 128 and 120. All of the component elements of mirror 410 may be made using the same materials and applied using the same techniques as described above with respect to the preceding embodiments. Preferably, however, the reflector/electrode material of layer 120 is made using nickel, chrome, rhodium, stainless steel, silver, silver alloys, platinum, palladium, gold, or combinations thereof.

The reflectance of the mirror in the signal light areas 222 or sensor area 224 may also be controlled by varying the percentage of those areas that are devoid of reflective material or by varying the thickness of the reflector/electrode coating. Further, the reflector/electrode material used to form lines 222b in signal light area may be different from the reflector/electrode material used for the remainder of the mirror. For example, a reflector/electrode material having a higher reflectance may be used in the signal light area such that the reflectivity in the signal light area is the same as that of the remainder of the mirror despite the regions therein that are devoid of reflector material. Preferably, the region of the signal light area that is devoid of reflective material constitutes between 30 and 50 percent of the signal light area and the area occupied by the reflective material is between 50 and 70 percent of the signal light area. To achieve

these percentages, the lines of reflector/electrode material are preferably about 0.010 inch wide and the spaces between the lines are about 0.006 inch wide.

The arrangement shown in Fig. 10C differs from that shown in Fig. 10B in that the reflective material is formed on the fourth surface (*i.e.*, the rear surface 114b of rear element 114). With such ao arrangement, the electrode 340 on the third surface is preferably made of a transparent material similar to that of the electrode 128 formed on the rear surface of front element 112. Like the arrangement shown in Fig. 10B, the structure shown in Fig. 10C includes a signal light area 222 having alternating regions of reflective material 222b and regions devoid of such reflective material 222a. In this manner, LEDs 254 may be more covertly hidden from view by the driver and yet light from LEDs 254 may project through all the layers of electrochromic mirror 410 so as to be visible by drivers of other vehicles. Similarly, if a day/night sensor 256 is provided, a sensor area 224 may be provided in the same manner with alternating regions of reflective material 224b and regions that are void of reflective material 224a.

A benefit of utilizing the above-described structure in connection with a signal ligbt is that the use of a dichroic coating may be avoided. Dichroic coatings are generally nonconductive and therefore cannot be used in an electrochromie mirror baving a third surface reflector. Also, the only current dichroic coatings that are economically feasible are those that transmit red and infrared light and reflect other colors of ligbt. Thus, to construct a practical signal ligbt, only LEDs that emit red light may be utilized. Accordingly, there is little flexibility in this regard wben a dichroic coating is utilized. To the contrary, with the structure of the present invention, any color signal light may be used.

The coocept of providing a window region baviog alternating areas devoid of reflective material may similarly be applied to a noo-electrochromic signal mirror. And although other materials may be used, chromium on the first or second surface of such a non-electrochromic mirror is the preseotly preferred reflective material.

Figs. 10D and 15 show yet another embodiment of the present invention as it pertains to signal mirrors. According to this embodiment, the signal mirror includes an additional structure for rendering the signal light more covert with respect to the field of view of the driver. While each of the embodiments relating to the signal mirrors discussed above covertly hides the signal light behind the mirror when they are not

energized and generally hides the signal light when activated, there remains the possibility with such embodiments that the driver may be distracted during the periods in which the signal light is activated. Specifically, while the LEDs of the signal light are angled outward away from the driver's eyes, the driver may still be able to see the LEDs as points of light through portions of the mirror assembly. Accordingly, this embodiment provides means for reducing the transmission of light from the signal light through the mirror in the direction of the driver. As explained below, this additional means may take on several alternative or additive forms.

Referring to Fig. 10D, a construction is shown whereby a baffle assembly 500 is positioned between signal light assembly 220 and the rear surface of mirror assembly 510. The particular baffle assembly 500 shown in Fig. 14D includes a forward, upper plate 502 and a rearward, lower plate 504 fixed in spaced and parallel relation by a plurality of legs 506. As illustrated in Figs. 14D and 19, lower plate 504 is laterally displaced relative to forward plate 502 in a more outward position away from the driver. Lower plate 504 ineludes a plurality of apertures 508 corresponding in size and position to each of LEDs 254. Upper plate 502 is disposed relative to aperture 508 and slightly over LEDs 254 so as to block the driver's view of LEDs 254. Upper plate 502 includes an aperture 509 through wbich light may pass so as to reach sensor 256. The spaces between upper plate 502 and lower plate 504 as well as apertures 508 in lower plate 504 provide a sufficient opening for light projected from the angled LEDs 254 to be transmitted through mirror 510 aod into region C shown in Fig. 15. Baffle assembly 500, as shown, is preferably made of a black plastic or the like.

The functionality of baffle assembly 500 may be supplemented or alternatively performed by various other mechanisms designated generally in Fig. 14D by reference numeral 520. Specifically, element 520 may be any one or a combination of a light control film, a layer of black or dark paint, or a heater element. A light control film, such as that available from the 3M Company under the trade designation LCF-P, may be used, which is a thin plastic film enclosing a plurality of closely spaced, black colored microlouvers. Such a light control film is disclosed for use in a conventional signal mirror in U.S. Patent Nos. 5,361,190 and 5,788,357. As disclosed in those patents, such a light control film may have a thickness of 0.030 inches, with the microlouvers spaced approximately 0.005 inches apart. The microlouvers are typically black and are

positioned at various angular positions to provide a suitable viewing angle. Such a light control film permits light from LEDs 254 to be transmitted at the appropriate viewing angle to reach region C (Fig. 11). The light control film also serves to block the light projected from LEDs 254 from travelling outside the appropriate viewing angle in the line of sight of the driver. Thus, unlike the baffle assembly 500 depicted in Figs. 10D and 15, such a light control film may be placed completely over and in front of each of LEDs 254. Further, sucb a light control film could also be made using other forms of optical elements, such as holograms and the like.

If element 520 is a coating of an opaque paint, such a coating would not extend far enough in front of the LEDs to block light from LEDs 254 to be transmitted through mirror 510 into blind spot area C (Fig. 11). Alternatively, such a coating of paint could extend completely in front of LEDs 254, provided it was configured to have some form of louver or equivalent structure formed in its surface in the areas of the intended transmission path of LEDs 254. For example, the thickness of such a paint coating could be controlled to create effective louvers using screen-printing, molding, stamping, or laser ablation. Further, if reflector/electrode 120 is configured in the manner described above with respect to Figs. 10B and 10C, element 520 could be a coating of black paint that has similar bars or stripes in the areas overlying LEDs 254 while having spacial relations relative to the bars 222b of reflector/electrode 120, so as to provide a transmission path at the appropriate angle for vehicles to view the lights when in the vehicle's blindspots, while blocking the light from the field of view of the driver. Further, as shown in Fig. 10D, the bars 222b of reflector/electrode 120 may be configured to have varying widths that decrease with increasing distance from the driver, so as to reduce peripheral transmittance through area 222 in the direction of the driver, or may have a less pronounced edge definition, as discussed above.

If element 520 is provided using a mirror heating element, the heating element could be provided to extend across the entire fourth surface of the mirror and have apertures formed in appropriate locations to allow light emitted from LEDs 254 to be transmitted at the appropriate angle.

Another mechanism for shielding the driver from light emitted from LEDs 254 is to increase the thickness of the reflector/electrode 120 in a region 530 corresponding to that of upper plate 502 thereby reducing the transmittance through that portion of

reflector/electrode 120. Currently, such reflector/electrodes have a transmittance of approximately 1-2 percent. To sufficiently shield the driver from light transmitted from LEDs 254, reflector/electrode 120 preferably has a thickness in region 530 that reduces the transmittance therethrough to less than 0.5 percent, and more preferably to less than 0.1 percent.

Element 520 may additionally or alternately include various optical films, such as a prismatic or Fresnel film or a collimating optical element as described in U.S. Patent No. 5,788,357 so as to collimate and direct the light emitted from LEDs 254 at the appropriate angle without also transmitting light in the direction of the driver.

As yet another possible solution, sidewalls 252 of light assembly 220 may be extended so as to space LEDs 254 further from the rear surface of mirror assembly 510, such that sidewalls 252 effectively block any light from LEDs 254 from being transmitted in the direction of the driver of the vehicle.

Although the structure shown in Fig. 10D shows mirror assembly 510 as including the reflector/electrode 120 as illustrated in the embodiment shown in Fig. 10B above, mirror assembly 510 could take on any of the other forms discussed above with respect to the embodiment described with respect to Fig. 10A or Figs. 3A-3G.

Although the present invention has been described as providing a signal light that is used as a turn signal, it will be appreciated by those skilled in the art that the signal light could function as any other form of indicator or signal light. For example, the signal light could indicate that a door is ajar so as to warn drivers of approaching vehicles that a vehicle occupant may be about to open a door into oncoming traffic, or the light behind the mirror may be an indicator light to indicate that the mirror heaters have been turned on, that another vehicle is in a blind spot, that the pressure is low, that a turn signal is on, or that freezing/hazardous conditions exist.

While the signal light of the present invention has been described above as preferably being made of a plurality of LEDs, the signal light may nevertheless be made of one or more incandescent lamps, or any other light source, and an appropriately colored filter without departing from the spirit or scope of the present invention.

Yet another embodiment of the present invention is shown in Figs. 16-18. In this embodiment, an exterior rearview mirror assembly 700 is provided having a housing 710 adapted for attachment to the exterior of a vehicle. Such mirrors are often mounted

to the vehicle door 730 or to the A-pillar of the vehicle. Within housing 710 is a mirror structure 720 and a light source 725 mounted behind mirror structure 720. Mirror 720 may be constructed in accordance with any of the above-noted embodiments, such that light emitted from ligbt source 725 may be projected through mirror 720. Mirror 720 may thus have a reflector having a masked window portion in front of light source 725 or may have a region 726 that is at least partially transmissive provided in front of light source 725. As yet another alternative, the region 726 in front of light source 725 may have a construction similar to that shown in Fig. 10 or the entire reflector in mirror 720 may be partially transmissive. As shown in Figs. 21 and 22, light source 725 is preferably mounted such that it projects light onto a region of the vehicle door 730 on which the vehicle door handle 735 and lock mechanism 737 are provided. Lock mechanism 737 may be a keyhole or touch pad as commonly used to enable the vehicle doors to be locked or unlocked.

Ligbt source 725 may be any type of ligbt source, and is preferably a white light source. A preferred light source is disclosed in commonly-assigned U.S. Provisional Patent Application No. 60/124,493, entitled "SEMICONDUCTOR RADIATION EMITTER PACKAGE," filed on March 15, 1999, by John K. Roberts.

Light source 725 may be activated so as to project light in response to the same actions to which the interior vehicle lights are turned on and off when providing illuminated entry into the vehicle. Thus, for example, light source 725 may illuminate a portion of door 730 when a person depresses the lock or unlock key on a key fob associated with the vehicle for remote keyless entry (RKE), when a person attempts to open the door, or when a person inserts a key into the lock mechanism 737. Alternatively, a motion sensor may be provided to activate light source 725. Preferably, light source 725 is disabled so as to be incapable of projecting light when the vehicle's ignition has been turned on.

By providing such a light source 725 within exterior rearview mirror housing 710, a light source may be mounted on the vehicle for illuminating the area on the exterior of the vehicle where a vehicle occupant must contact to enter the vehicle. Such a feature is advantageous when the vehicle is parked in particularly dark locations.

While light source 725 has been described as being mounted to project light at door handle 735, it will be appreciated that light source 725 could be mounted so as to

project light also onto the ground region or other areas of the exterior of the vehicle as well as to the door handle. This could be accomplished by providing appropriate optics between light source 725 and mirror structure 720. Additional light sources could also be mounted so as to project light onto these areas.

The transflective (*i.e.*, partially transmissive, partially reflective) rearview mirror described above allows the display of information to the driver without removing a portion of the reflective coating. This results in a more aesthetically pleasing appearance and allows the mirror to appear as a contiguous reflector when the display is off. An example of a display particularly suited to this application is a compass display.

Many mirrors are sold each year which have the added feature of displaying the heading of a vehicle using an alpha-numeric Vacuum Fluorescent Display (VFD) capable of displaying eight compass directions (N, S, E, W, NW, SW, NE, SE). These types of displays are used in many other applications in motor vehicles such as radios and clocks. These displays have a glass cover over the phosphor digit segments. When used with a transflective mirror, the majority of the light from the VFD is not transmitted through the mirror but reflected back to the display. A portion of this reflected light is then reflected off both the top and bottom surfaces of the cover glass of the VFD and back through the mirror. These multi-bounce reflections result is ghost or double images in the display which are highly undesired. As discussed above, a solution to this problem is to provide an anti-reflection coating on the cover glass of the VFD, however, such an anti-reflection coating adds to the cost of the display. Other disadvantages of VFD displays is that they are expensive and fragile.

An LED alpha-numeric display is a viable alternative to a vacuum fluorescent display for use in a transflective mirror. As discussed above, LED displays do not have a specular cover glass and thus do not suffer from ghost reflection problems. Additionally, the area surrounding the LEDs can be colored black to further aid in suppressing spurious reflections. LEDs also have the advantage of having extremely high reliability and long life. Segmented alpha-numeric LED displays are commercially available but are complicated to manufacture and it is difficult to maintain segment to segment brightness and color consistency. Finally, it is also difficult to prevent ligbt from one segment from bleeding into another segment. LEDs are also only available in saturated highly monochromatic colors, with the exception of some phosphor-LED

combinations, which are currently very expensive. Many automotive manufacturers have display color schemes which are more broad spectrum and difficult, if not impossible to match with LED technologies. Most cars manufactured in the United States have a blue display color scheme, which could only be matched with blue LEDs which are currently very expeosive.

An alternative to a segmented LED or VFD display is described below that overcomes the above problems associated with LEDs and VFDs. While the following description is related to a compass display, the concepts could readily be extended to a variety of information displays, such as a temperature display and various warning lights. The compass display is used as an example in the preferred embodiment because it best illustrates the features and advantages of the invention. Also, the following description will concentrate on the use of LEDs as the preferred light source. However, many other light sources are also applicable, such as incandescent bulbs or new emerging technologies such as light emitting polymers and organic LEDs. The graphical, rather than alpha-numerical, nature of this display clearly distinguishes it from other alpha-numerical displays in a vehicle (such as the clock, etc.). Therefore, it will not look undesirable if this display does not match the color scheme of the VFD displays throughout the vehicle, allowing the use of more efficient and cost effective displays. In fact, the contrasting colors of the display should contribute to the aesthetics of the vehicle interior.

The display in the preferred embodiment coosists of multiple LEDs, a graphical applique masking layer, and a transflective mirror. A front view of the masking layer is shown in Figs. 19A and 19B. The graphical applique shows eight points of a compass (801-808). The applique in Fig. 19A includes all eight directions, however, only one of the eight directions, as shown in Fig. 19B, will be lit depending on the direction of travel. The region of the mirror containing the other directions will be reflective and not indicate any content. A center graphic (809) may be an emblem, such as the globe in Figs. 19A and 19B, can be added for cosmetic appeal. The globe can be illuminated by an LED of a color contrasting the color of the direction indicators.

Various methods of controlling the segments are contemplated. In the simplest form, only one of the LEDs behind the eight compass direction indicators is illuminated at a given time, depending on the direction of travel. In another scheme, all eight

indicators are lit dimly and the indicator corresponding to the current direction of travel is lit more brightly than the other eight. In yet another scheme, bicolor LEDs are used and the LED indicator corresponding to the current direction of travel is set to a different color than the other eight. A final alternative would be to have only the indicator corresponding to the current direction of travel lit, but gradually fade from one indicator to another as the car changes directions.

The construction of the display is described with reference to Figs. 20 and 21. Fig. 20 shows the arrangement of LEDs on a circuit board and Fig. 21 shows an exploded view of the display assembly. The LEDs (812) are arranged on a circuit board (811) in a pattern corresponding to the locations of the indicators and center graphic. LEDs (812) may be of the type trade named "Pixar" by Hewlett Packard. Due to the loss of light in the transflective coating, bright LEDs are needed. AlInGaP based LEDs are suitable for this application and are available in greed, red, amber, and various similar colors. Blue and green colors can be achieved by using InGaN LEDs. Although InGaN LEDs are currently expensive, there are many fewer LEDs needed than would be used in a segmented display. As an alternative to using packaged LEDs such as the "Pixar" LED, they can be bonded to the circuit board directly using a technique commonly known in the industry as Chip-On-Board.

The circuit board (811) is positioned behind the mirror using spacer (813). The spacer (813) serves multiple purposes. First, the spacer positions the circuit board a distance from the mirror, 1/4 inch for example, such that the light from the LED fully covers the indicator. Second, the spacer prevents cross talk between indicators by preventing light from one cavity from entering aoother cavity. To achieve this, the spacer should be made from a white, highly reflective material. At the least, the spacer must be opaque. Finally, the spacer serves to help reflect light exiting the LED at high angles back towards the indicator. This improves the efficiency of the system. The spacer may even be constructed with a parabolic bowl surrounding the LED to most effectively direct light forward. A lambertian scattering surface on the spacer will also help diffuse the light and improve the uniformity of the indicator illumination. The empty region between the circuit board (811) and the mirror (815) formed by the openings in the spacer (813) may be filled with an epoxy or silicone containing a

diffusant. This will help further diffuse the light and help the indicators appear more uniform.

An applique (814) is provided in a masking layer made of a thin material which has a black matte mask covering all areas but the graphical indicators. The regions for the graphic are a clear or somewhat white and diffuse. The applique may be formed by silk-screening the black mask pattern onto a film of diffuse plastic. Preferably, the side of the applique facing the LEDs is also screened with a white ink. This will allow light which does not pass through the letters or graphical region to reflect back onto the LED and spacer where it may then partially reflect back forward. Alternatively, the applique can be formed by directly silk screening the black mask onto the back surface of mirror (815). The manner by which such an applique may be constructed is disclosed in U.S. Patent Application No.09/311,029, entitled "REARVIEW MIRROR DISPLAY," filed on May 13, 1999, by Wayne J. Rumsey et al.

While the invention has been described in detail herein in accordance with certain preferred embodiments thereof, many modifications and changes therein may be effected by those skilled in the art without departing from the spirit of the invention. Accordingly, it is our intent to be limited only by the scope of the appending claims and not by way of the details and instrumentalities describing the embodiments shown herein.

The invention claimed is:

1. An electrochromic rearview mirror comprising:

front and rear elements each having front and rear surfaces and being sealably bonded together in a spaced-apart relationship to define a chamber;

a transparent first electrode including a layer of conductive material carried on a surface of one of said elements;

an electrochromic material contained in said chamber; and

a partially transmissive, partially reflective second electrode disposed over substantially all of said front surface of said rear element, said second electrode including a transparent electrically conductive coating applied over a surface of said rear element and a thin reflective layer of metal applied over said transparent electrically conductive coating, wherein said electrochromic rearview mirror exhibits a reflectance of at least about 35 percent, a transmittance of at least about 5 percent in at least portions of the visible spectrum, and a C* value of less than about 20.

2. An electrochromic mirror for use in a rearview mirror assembly having an electronic device positioned behind the electrochromic mirror for selectively projecting and/or receiving light therethrough, said electrochromic mirror comprising:

front and rear spaced elements, each having front and rear surfaces and being sealably bonded together in a spaced-apart relationship to define a chamber;

a transparent first electrode including a layer of conductive material carried on a surface of one of said elements;

an electrochromic material contained within said chamber; and

a second electrode overlying said front surface of said rear element in contact with said electrochromic material, said second electrode including a reflective layer of reflective material and a coating of electrically conductive material that is at least partially transmissive and is disposed over substantially all of the front surface of said rear element, wherein said second electrode includes a region in front of the electronic device that is at least partially transmissive.

3. The electrochromic mirror as defined in claim 2, wherein the electronic device is a light source.

4. The electrochromic mirror as defined in claim 3, wherein said light source is an indicator light.

5. The electrochromic mirror as defined in claim 3, wherein said light source is a signal light.

6. The electrochromic mirror as defined in claim 3, wherein said light source is a display.

7. The electrochromic mirror as defined in claim 6 and further including an electronic compass electrically coupled to said information display for displaying a vehicle heading.

8. The electrochromic mirror as defined in claim 3, wherein said light source is positioned behind said mirror so as to emit light, when activated, through said mirror, and through said region of said reflective coating that is devoid of reflective material toward a side of the vehicle.

9. The electrochromic mirror as defined in claim 2 and further including a mirror heating element mounted to a rear surface of said rearview mirror in front of said electronic device, said heating element including at least one aperture through which light may be transmitted.

10. The electrochromic mirror as defined in claim 2, wherein said electronic device is a light sensor.

11. The electrochromic mirror as defined in claim 10, wherein said second electrode is partially transmissive and partially reflective over substantially all of the front surface of said rear element.

12. The electrochromic mirror as defined in claim 11, wherein said light sensor includes a sensor component and a collector component disposed between said rear surface of said rear element and said sensor component, said collector component serving to collect light over an area greater than a sensing area of said sensor component so as to direct at least a portion of the collected light to said sensor component.

13. The electrochromic mirror as defined in claim 12, wherein said collector component is a lens that condenses the collected light towards a focal plane of the lens.

14. The electrochromic mirror as defined in claim 13, wherein said sensor component is positioned in front of the focal plane of said lens.

15. The electrochromic mirror as defined in claim 10, wherein said second electrode is a partially reflective, partially transmissive electrode that is formed over substantially all of said front surface of said rear element, and includes a transparent electrically conductive coating, and a thin reflective layer of silver or silver alloy applied over said transparent electrically conductive coating.

16. The electrochromic mirror as defined in claim 2 and further including an organic light emitting diode display mounted to one of the surfaces of said front or rear elements.

17. The electrochromic mirror as defined in claim 16, wberein said organic light emitting diode display is mounted in said chamber.

18. The electrochromic mirror as defined in claim 16, wherein said organic light emitting display is mounted in front of said reflective electrode/reflector.

19. The electrochromic mirror as defined in claim 16, wherein said ligbt emitting display is substantially transparent.

20. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said electrochromic rearview mirror bas a C* value less than about 15.

21. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said electrochromic rearview mirror has a C* value less than about 10.

22. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said electrochromic rearview mirror has a b* value less than about 15.

23. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said electrochromic rearview mirror bas a b* value less than about 10.

24. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said electrochromic mirror has a reflectance of at least about 65 percent.

25. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said electrochromic mirror has a reflectance of at least about 70 percent.

26. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said electrochromic mirror has a transmittance of at least about 10 percent in at least portions of the visible spectrum.

27. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said reflective layer is made of a silver alloy including a combination of silver and an element selected from the group consisting of gold, platinum, rhodium, and palladium.

28. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said reflective layer is made of a silver alloy including about 94 percent silver and about 6 percent gold.

29. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said reflective layer has a thickness of between about 180 and 500 Å.

30. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said transparent conductive coating includes a layer of fluorine-doped tin oxide.

31. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said transparent conductive coating includes a layer of indium tin oxide.

32. The electrochromic rearview mirror as defined in claim 30, wherein said transparent conductive coating includes a second layer of transparent material between said layer of indium tin oxide and said rear element.

33. The electrochromic rearview mirror as defined in claim 32, wherein said second layer is made of silicon.

34. The electrochromic rearview mirror as defined in claim 32, wherein said second layer is made of titanium dioxide.

35. The electrochromic rearview mirror as defined in claim 34, wherein said transparent conductive coating further includes a third layer of silica and a fourth layer of indium tin oxide between said first indium tin oxide layer and said reflective layer.

36. The electrochromic rearview mirror as defined in any of claims 1, 2, 30, and 31, wherein said reflective layer includes a layer of silver and said mirror further includes a flash layer of silver alloy disposed over said layer of silver.

37. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said transparent conductive coating includes a layer of silicon.

38. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said first electrode is disposed on the rear surface of said front element.

39. The electrochromic rearview mirror as defined in any of claims 1, 2, 30, and 31, wherein said transparent electrically conductive coating having an optical thickness of $m\lambda/4$, where λ equals about 500 nm and m is a positive, odd integer.

40. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said second electrode includes a layer of indium tin oxide and a thin reflective layer of silver or silver alloy applied over said indium tin oxide layer, said indium tin oxide layer having one of a ¼ wave, ¾ wave, 1¼ wave, and 1¾ wave thickness.

41. The electrochromic rearview mirror as defined in any of claims 1 and 2, wherein said second electrode having a reflectance of at least about 35 percent, a transmittance of

at least about 5 percent in at least portions of the visible spectrum, and a C* value of less than about 20.

42. The electrochromic rearview mirror as defined in any of claims 1, 2, and 41, wherein said second electrode having a reflectance of at least about 35 percent, a transmittance of at least about 5 percent in at least portions of the visible spectrum, and a b* value of less than about 15.

43. The electrochromic mirror as defined in claim 2, where, in the region of said second electrode in front of the electronic device, said layer of reflective material has a thickness less than that in other regions of said second electrode.

44. The electrochromic mirror as defined in claim 43, wherein said layer of reflective material has a thickness of between 40 Å and 150 Å in said region in front of the electronic device.

45. The electrochromic mirror as defined in claim 44, wherein said layer of reflective material has a thickness of between 100 Å and 1000 Å in said other regions.

46. The electrochromic mirror as defined in claim 2, where, in the region of said second electrode in front of the electronic device, said second electrode is entirely devoid of said reflective material.

47. The electrochromic mirror as defined in claim 2, wherein said layer of reflective material is a thin layer of silver or silver alloy applied over substantially all of said electrically conductive coating such that substantially the entire region of said second electrode is partially transmissive and partially reflective.

48. The electrochromic mirror as defined in any of claims 1 and 2, wherein said front and rear elements are made of glass.

49. The electrochromic mirror as defined in claim 2, wherein said electrically conductive coatiog includes a first layer of a first partially reflective conductive material.

50. The electrochromic mirror as defined in claim 49, wherein said first partially reflective conductive material is selected from the group consisting essentially of: chromium, chromium-molybdenum-nickel alloys, nickel-iron-chromium alloys, stainless steel, and titanium.

51. The electrochromic mirror as defined in claim 49, wherein said electrically conductive coating includes a second layer of a second partially reflective conductive material, disposed between said first layer and said layer of reflective material.

52. The electrochromic mirror as defined in claim 51, wherein said second partially reflective conductive material is selected from the group consisting essentially of: molybdenum, rhodium, nickel, stainless steel, and titanium.

53. The electrochromic mirror as defined in claim 51, wherein at least one of said first and second layers is thinner in the region of said second electrode in front of the electronic device.

54. The electrochromic mirror as defined in any of claims 1 and 2, wherein said second electrode further includes at least one flash over-layer disposed over said reflective layer, where said flash over-layer comprises a material selected from the group consisting esseotially of: rhodium, molybdenum, and platinum.

55. The electrochromic mirror as defined in claim 2, wherein said secood electrode has a transmittance of between 10 and 50 percent in said region in front of the electronic device.

56. The electrochromic mirror as defined in claim 55, wherein said second electrode has a reflectance of between 50 and 80 percent in said other regions.

57. The electrochromic mirror as defined in any of claims 1 and 2 and further including a housing in which said electrochromic mirror and the electrooic device are mounted, said housing having a mountiog member for mounting said housing to the exterior of a vehicle.

58. The electrochromic mirror as defined in claims 1 and 2 and further including a housing in which said electrochromic mirror and the electronic device are mounted, said housing having a mounting member for mounting said housing to the interior of a vehicle.

59. The electrochromic mirror as defined in claim 3 and further includiog means disposed in front of said light source for reducing the transmission of light from said light source through the mirror in the direction of the driver.

60. The electrochromic mirror as defioed in claim 59, whereln said means for reducing transmission including any ooe or combioation of elements selected from the group consisting of: a light control film, a baffle assembly, a coating of paint, a heating element, a thickeoed reflective layer, a fresoel lens, a prismatic lens, and a collimating lens.

61. The electrochromic mirror as defined in claim 2, wherein all of said secood electrode is partially transmissive and partially reflective.

62. The electrochromic mirror as defined in claim 3, wherein said second electrode is more transmissive in a region of the spectrum corresponding to the light transmitted from the light source than for other regions of the visible spectrum.

63. The electrochromic mirror as defined in claim 3, wherein said second electrode is less reflective in a regioo of the spectrum corresponding to the light transmitted from the light source than for other regions of the visible spectrum.

64. The electrochromic mirror as defined in claim 2, wherein said second electrode includes an electrically conductive coating comprising:

a first layer of a first material selected from the group consisting of tin-doped indium oxide, titanium dioxide, and tin dioxide adjacent said front surface of said second substrate;

a second layer of silicon dioxide adjacent said first layer; and

a third layer of said first material adjacent said second layer.

65. The electrochromic mirror as defined in claim 64 further including a layer of a reflective material adjacent said third layer.

66. The electrochromic mirror as defined in claim 2, wherein said second electrode has an average luminous reflectance of at least 60 percent over all visible wavelengths and an average transmittance of at least 10 percent in a 585 to 650 nm wavelength range.

67. The electrochromic mirror as defined in claim 2, wherein said electrode has an average luminous reflectance of at least 35 percent over all visible wavelengths and an average transmittance of at least 10 percent in a 585 to 650 nm wavelength range.

68. The electrochromic mirror as defined in any of claims 1 and 2, wherein said electrochromic medium includes at least one solution-phase electrochromic material contained within said chamber in contact with said second electrode.

69. The electrochromic mirror as defined in any of claims 1 and 2 and further including a coating on the rear surface of said rear element that reflects any blue light transmitted through said second electrode back through the mirror.

70. The electrochromic mirror as defined in claim 69, wherein said coating on the rear surface of said rear element is blue paint.

71. The electrochromic mirror as defined in claim 2, wherein said second electrode comprises:

a first layer of a first material having a relatively high refractive index;

a second layer of a second material having a relatively low refractive index disposed on said first layer; and

a third layer of a third material disposed on said second layer, said third material having a relatively high refractive index.

72. The electrochromic mirror as defined in claim 71, wherein said third material is same as said first material.

73. The electrochromic mirror as defined in claim 72, wherein said first and third materials are selected from the group consisting essentially of tin-doped indium oxide, titanium dioxide, tin dioxide, tantalum pentoxide, zinc oxide, zirconium oxide, iron oxide, and silicon.

74. The electrochromic mirror as defined in claim 71, wherein said first, second, and third materials are electrically conductive.

75. The electrochromic mirror as defined in claim 71 and further including a fourth layer of an electrically conductive material disposed on said third layer.

76. The electrochromic mirror as defined in claim 75, wherein said fourth layer is made of an electrically conductive, reflective material.

77. The electrochromic mirror as defined in claim 75, wherein said fourth layer is made of an electrically conductive transparent material.

78. The electrochromic mirror as defined in claim 71, wherein said second electrode has an average luminous reflectance of at least about 60 percent over all visible wavelengths and an average transmittance of at least 10 percent in 585 to 650 nm wavelength range.

79. The electrochromic mirror as defined in claim 71, wherein said second electrode has an average luminous reflectance of at least about 35 percent over all visible wavelengths and an average transmittance of at least about 10 percent in 585 to 650 nm wavelength range.

80. The electrochromic mirror as defined in claim 71 and further including a fourth layer of a silver/silver alloy disposed on said third layer, wherein said first material is tin-doped indium oxide, said second material is silicon dioxide, and said third material is tin-doped indium oxide.

81. The electrochromic mirror as defined in claim 2, wherein said second electrode comprises:

a first layer of a first material having a relatively high refractive index;

a second layer of a second material having a relatively low refractive index disposed on said first layer; and

a third layer of an electrically conductive third material disposed on said second layer.

82. The electrochromic mirror as defined in claim 81, wherein said electrically conductive third material is a reflective material.

83. The electrochromic mirror as defined in claims 76 and 82, wherein said reflective material is silver or silver alloy.

84. The electrochromic mirror as defined in claim 83, wherein said layer of reflective material has a thickness of about 150 Å to 300 Å.

85. The electrode as defined in claim 83, wherein said layer of reflective material has a thickness of about 160 Å.

86. The electrode as defined in claim 81, wherein said electrically conductive third material is substantially transparent.

87. The electrode as defined in claims 77 and 86, wherein said electrically conductive transparent material is indium tin oxide.

88. The electrode as defined in claims 71 and 81, wherein said first material is selected from the group consisting essentially of tin-doped indium oxide, titanium dioxide, tin dioxide, tantalum pentoxide, zinc oxide, zirconium oxide, iron oxide, and silicon.

89. The electrode as defined in claim 88, wherein said first layer has a thickness of about 200 Å to 800 Å .

90. The electrode as defined in claims 71 and 81, wherein said second material is selected from the group consisting essentially of silicon dioxide, niobium oxide, magnesium fluoride, and aluminum oxide.

91. The electrode as defined in claim 90, wherein said second layer has a thickness of about 400 Å to 1200 Å.

92. The electrode as defined in claims 71 and 81, wherein said third material is selected from the group consisting essentially of tin-doped indium oxide, titanium dioxide, tin dioxide, tantalum pentoxide, doped zinc oxide, zirconium oxide, iron oxide, and silicon.

93. The electrode as defined in claim 92, wherein said third layer has a thickness of about 600 Å to 1400 Å.

94. The electrode as defined in claim 81, wherein said second electrode has an average luminous reflectance of at least about 50 percent over all visible wavelengths and an average transmittance of at least about 40 percent in 585 to 650 nm wavelength range.

95. The electrode as defined in claims 71 and 81, wherein said second electrode has a sheet resistance of less than about 100 Ω/□.

96. The electrode as defined in claim 81, wherein said first layer is made of tin-doped indium oxide, said second layer is made of silicon dioxide, and said third layer is made of silver/silver alloy.

97. The electrode as defined in claim 81, wherein said first layer is made of silicon, said second layer is made of silicon dioxide, and said third layer is made of tin-doped indium oxide.

98. A rearview mirror assembly for a vehicle comprising:

a housing adapted to be mounted to the vehicle;

front and rear elements mounted in said housing, said elements each having front and rear surfaces and being sealably bonded together in a spaced-apart relationship to define a chamber;

an electrochromic material contained in said chamber;

a transparent first electrode including a layer of conductive material carried on a surface of one of said elements;

a second electrode disposed on said front surface of said rear element;

a light emitting display assembly mounted in said housing; and

a reflection reducer for minimizing light that is emitted from said display assembly from reflecting off of said reflective electrode/reflector back toward said display assembly and then reflecting back off said front surface of said display assembly toward said front surface of said front element and a viewer,

wherein either said second electrode is a reflective electrode or a separate reflector is disposed over substantially all of said rear surface of said rear element, said reflective electrode/reflector being partially transmissive and partially reflective in at least a location in front of said display assembly.

99. The rearview mirror assembly as defined in claim 98, wherein said display assembly has a front surface, and said reflection reducer is a structure for mounting said display assembly behind said rear surface of said rear element such that said front surface of said display assembly is not parallel with said rear surface.

100. The rearview mirror assembly as defined in claim 98, wherein said reflection reducer is a non-specular front surface of said display assembly that is mounted adjacent said rear surface of said rear element.

101. The rearview mirror assembly as defined in claim 100, wherein any light emitted from said display assembly that is reflected back through said rear element from said

reflective electrode/reflector and impinges upon said non-specular front surface of said display assembly is not reflected back through said rear element.

102. The rearview mirror assembly as defined in claim 98, wherein said display assembly has a front surface that is mounted adjacent said rear surface of said rear element, and

said reflection reducer is an anti-reflection coating applied to said front surface of said display assembly.

103. The rearview mirror assembly as defined in claim 98, wherein said display assembly has a front surface that is mounted adjacent said rear surface of said rear element, said reflection reducer including at least one masking component for minimizing light that is emitted from said display assembly from reflecting off of said reflective electrode/reflector back toward said display assembly and then reflecting back off said front surface of said display assembly toward said front surface of said front element and a viewer.

104. The rearview mirror assembly as defined in claim 98 and further including a light absorbing layer provided on said rear surface of said rear element, said light absorbing layer having an aperture window formed therein through which said display assembly emits light, wherein said display assembly is mounted at an angle behind said rear surface of said rear element such that any light emitted from said display assembly that is reflected back through said rear element from said reflective electrode/reflector impinges upon and is substantially absorbed by said light absorbing layer.

105. The rearview mirror assembly as defined in claim 98, wherein said second electrode is a reflective electrode being partially transmissive and partially reflective over substantially all of said front surface of said rear element.

106. The rearview mirror assembly as defined in claim 105, wherein said reflective electrode includes a transparent electrically conductive coating, and a thin reflective layer of silver or silver alloy applied over said transparent electrically conductive coating.

107. The rearview mirror assembly as defined in claim 106, wherein said reflective electrode is partially transmissive and partially reflective with a reflectance of at least about 50 percent and a transmittance of at least about 10 percent in at least portions of the visible spectrum.

108. The rearview mirror assembly as defined in claim 98, wherein said display assembly includes a display device and an optical element positioned between said display device and said rear surface of said rear element, wherein said front surface of said display assembly that is not parallel with said rear surface of said rear element is a surface of said optical element.

109. The rearview mirror assembly as defined in claim 108, wherein said optical element is a mirror.

110. The rearview mirror assembly as defined in any of claims 6 and 98, wherein said display is a graphic display.

111. The rearview mirror assembly as defined in claim 110, wherein said graphic display includes a masking layer provided behind said rear surface of said rear element and having an indicia formed therein that is at least partially transmissive, said graphic display further including at least one light source mounted behind said masking layer for selectively projecting light through said indicia and through said front and rear elements, said electrochromic material, said first and second electrodes, and through said partially reflective, partially transmissive region of said reflective electrode/reflector.

112. The rearview mirror assembly as defined in claim 110, wherein said at least one light source is a light emitting diode.

113. The rearview mirror assembly as defined in claim 110, wherein said graphic display is a graphic compass display.

114. The rearview mirror assembly as defined in claim 113, wherein said graphic compass display includes a masking layer provided behind said rear surface of said rear element and having an indicia formed therein that is at least partially transmissive, said indicia including at least the letters N, E, S, and W arranged in a circle, said graphic display further including at least four light sources mounted behind said masking layer each for selectively projecting light through a respective one of said letters of said indicia and through said front and rear elements, said electrochromic material, said first and second electrodes, and through said partially reflective, partially transmissive region of said reflective electrode/reflector.

115. The rearview mirror assembly as defined in claim 109, wherein said indicia further includes the letters NE, SE, SW, and NW and said graphic compass display further including four additional light sources each associated with one of the letters NE, SE, SW, and NW.

116. The rearview mirror assembly as defined in claim 115, wherein said light sources are light emitting diodes.

117. The rearview mirror assembly as defined in claim 116, wherein said light emitting diodes are mounted on a printed circuit board behind said rear element and said masking layer.

118. The rearview mirror assembly as defined in claim 115 and further including a compass circuit mounted in said housing for selectively activating said light sources of said graphic compass display so as to illuminate one of said letters of said indicia and display the vehicle's current heading.

119. The rearview mirror assembly as defined in claim 114, wherein said indicia further includes an emblem in the center of the circle of letters and said graphic compass display further includes a light source mounted behind said emblem for selectively projecting light therethrough.

120. The rearview mirror assembly as defined in claim 119, wherein said second electrode is a reflective electrode that is partially reflective, partially transmissive over substantially all of said front surface of said rear element.

121. The rearview mirror assembly as defined in claim 120, wherein said reflective electrode includes a transparent electrically conductive coating, and a thin reflective layer of silver or silver alloy applied over said transparent electrically conductive coating.

122. The rearview mirror assembly as defined in claim 120, wherein said reflective electrode has a reflectance of at least about 35 percent.

123. The rearview mirror assembly as defined in claim 111 wherein said masking layer is substantially light absorbent over its entire surface with the exception of those areas of the indicia.

124. A rearview mirror assembly for a vehicle comprising:

an electrochromic mirror including front and rear spaced elements sealably bonded together in a spaced-apart relationship to define a chamber therebetween, a

reflective coating including at least one layer of a reflective material disposed on a front surface of said rear element, and an electrochromic reversibly variable transmittance medium contained in said chamber; and

a signal light mounted behind said electrochromic mirror for selectively projecting light through said electrochromic mirror.

125. The rearview mirror assembly as defined in claim 124 and further including a variable attenuator coupled to a device remote from the mirror assembly via a dedicated line, wherein said variable attenuator controls the intensity of said signal light in response to a signal sent from the remote device over the dedicated line.

126. The rearview mirror assembly as defined in claim 124, and further including a sensor mounted behind said electrochromic mirror.

127. The rearview mirror assembly as defined in claim 126, wherein said electrochromic mirror further includes a sensor area disposed within said reflective coating in front of said sensor and having regions containing reflective material and regions substantially devoid of reflective material, wherein said reflective material is effective to reflect light through at least said front element and said electrochromic medium when the light reaches said reflective material after passing through at least said front element and said electrochromic medium.

128. The rearview mirror assembly as defined in claim 124, wherein said electrochromic mirror further includes a signal light area disposed within said reflective coating in front of said signal light, said signal light area having regions containing reflective material and regions substantially devoid of reflective material, wherein said reflective material is effective to reflect light through said electrochromic medium and said front element when the light reaches said reflective material after passing through said front element and said electrochromic medium.

129. The rearview mirror assembly as defined in claim 124, wherein said reflective coating is provided on a front surface of said rear element and includes at least one layer of material that is electrically conductive and reflective.

130. A rearview mirror assembly for a vehicle comprising:

an electrochromic mirror;

a signal light mounted behind said electrochromic mirror for selectively projecting light through said electrochromic mirror; and

a variable attenuator coupled to a device remote from the mirror assembly via a dedicated line, wherein said variable attenuator controls the intensity of said signal light in response to a signal sent from the remote device over the dedicated line.

131. The rearview mirror assembly as defined in any one of claims 124 and 130, wherein said signal light is selectively actuated in response to a turn indication signal so as to function as a turn signal light.

132. The rearview mirror assembly as defined in any of claims 124 and 130 and further including a day/night sensing circuit including a sensor for detecting whether any daylight is impinging upon said electrochromic mirror, said day/night sensing circuit controls the intensity of the signal light in response to the detection made by said sensor.

133. The rearview mirror assembly as defined in claim 132 wherein said day/night sensing circuit increases the intensity of the light source when daylight is detected and decreases the intensity when no daylight is detected.

134. The rearview mirror assembly as defined in claims 124 and 130, wherein said signal light emits red light.

135. The rearview mirror assembly as defined in claims124 and 130, wherein said signal light emits amber light.

136. The rearview mirror assembly as defined in claims 124 and 130 and further including a housing in which said mirror and said signal light are mounted, said housing having a mounting member for mounting said housing to the exterior of a vehicle.

137. The rearview mirror assembly as defined in claims 124 and 130 and further including means disposed in front of said signal light for reducing the transmission of light from said signal light through the mirror in the direction of the driver.

138. The rearview mirror assembly as defined in claim 137, wherein said means for reducing transmission including any one or combination of elements selected from the group consisting of: a light control film, a baffle assembly, a coating of paint, a heater element, a thickened reflective layer, a fresnel lens, a prismatic lens, and a collimating lens.

139. The rearview mirror assembly as defined in any of claims 124 and 130, wherein said signal light includes a plurality of LEDs.

140. A rearview mirror assembly for a vehicle comprising:

a mirror including a transparent substrate, a reflective coating formed on a surface of said substrate, and a partially transmissive/reflective area disposed within said reflective coating, said partially transmissive/reflective area having regions containing reflective material and regions substantially devoid of reflective material; and

an electronic device mounted behind said partially transmissive/reflective area of said mirror for selectively for receiving and/or projecting light through said mirror, wherein said reflective material is effective to reflect light through said substrate when light reaches said reflective material after passing through said substrate.

141. The rearview mirror assembly as defined in claim 140, wherein said electronic device is a light source for selectively projecting light through said mirror.

142. The rearview mirror assembly as defined in claim 141, wherein said light source is a signal light.

143. The rearview mirror assembly as defined in claim 141, wherein said light source is an information display.

144. The rearview mirror assembly as defined in claim 141, wherein said light source is an indicator light.

145. The rearview mirror assembly as defined in claim 141, wherein said light source is positioned behind said mirror so as to emit light, when activated, through said mirror, and through said region of said reflective coating that is devoid of reflective material toward a side of the vehicle.

146. The rearview mirror assembly as defined in claim 141, wherein said region devoid of said reflective material allows viewing of said light source.

147. The rearview mirror assembly as defined in claim 141 and further including means disposed in front of said light source for reducing the transmission of light from said light source through the mirror in the direction of the driver.

148. The rearview mirror assembly as defined in claim 148, wherein said means for reducing transmission including any one or combination of elements selected from the group consisting of: a light control film, a baffle assembly, a coating of paint, a heater element, a thickened reflective layer, a fresnel lens, a prismatic lens, and a collimating lens.

149. The rearview mirror assembly as defined in claim 140, wherein said electronic device is a sensor for sensing light transmitted through said electrochromic mirror.

150. The rearview mirror assembly as defined in claim 140, wherein said mirror further includes an electrochromic medium.

151. The rearview mirror assembly as defined in claim 150, wherein the coloration of the electrochromic medium proximate said partially transmissive/reflective area is generally uniform with the coloration of the electrochromic medium in the remaining area of said mirror.

152. The rearview mirror assembly as defined in claim 140, wherein said region containing reflective material comprises about 50-70 percent of said area and said region devoid of reflective material comprises about 30-50 percent of said area.

153. The rearview mirror assembly as defined in claim 140, wherein said region containing reflective material includes a plurality of lines of reflective material that are separated by lines substantially devoid of reflective material.

154. The rearview mirror assembly as defined in claim 153, wherein said lines of reflective material and lines devoid of reflective material are vertical.

155. The rearview mirror assembly as defined in claim 153, wherein said lines of reflective material have a width of approximately 0.010 inch and said lines devoid of reflective material have a width of approximately 0.006 inch.

156. The rearview mirror assembly as defined in claim 140 and further including a housing in which said electrochromic mirror and said light source are mounted, said housing having a mounting member for mounting said housing to the exterior of a vehicle.

157. The rearview mirror assembly as defined in claim 140 and further including a housing in which said electrochromic mirror and said light source are mounted, said housing having a mounting member for mounting said housing to the interior of a vehicle.

158. The rearview mirror assembly as defined in claim 140, wherein said regions containing reflective material have decreasing reflectivity in areas adjacent said region substantially devoid of reflective material.

159. An exterior rearview mirror assembly for a vehicle comprising:

a housing adapted to be mounted to the exterior of the vehicle;

a first element mounted in said housing, said first element having a front and rear surface;

a reflector disposed on one of the surfaces of said first element; and

a light source mounted in said housing behind said rear surface of said first element, said light source being positioned within said housing so as to emit light, when activated, through said first element, and through a region of said reflector that is at least partially transmissive toward a side of the vehicle.

160. The exterior rearview mirror assembly as defined in claim 159, wherein said light source emits light towards the door handle and/or locking mechanism of the vehicle.

161. The exterior rearview mirror assembly as defined in claim 159 and further including:

a second element mounted in said housing in front of said first element, said second element having a front and rear surface and being sealably bonded to said first element in a spaced-apart relationship to define a chamber;

an electrochromic material contained in said chamber;

a transparent first electrode including a layer of conductive material carried on a surface of one of said elements; and

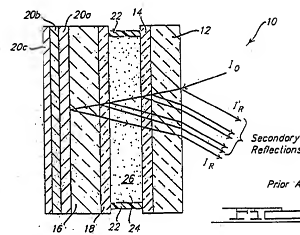
a second electrode disposed on said front surface of said first element,

wherein said light source is mounted behind said first element so as to emit light, when activated, through said first and second elements, said electrochromic material, said first and second electrodes, and through a region of said reflector that is at least partially transmissive toward a side of the vehicle.

162. The exterior rearview mirror assembly as defined in claim 161, wherein said second electrode is reflective to thereby serve as said reflector and constitute a reflective electrode.

163. The exterior rearview mirror assembly as defined in claim 162, wherein said reflective electrode is formed over substantially all of said front surface of said first element, said reflective electrode including a transparent electrically conductive coating, and a thin reflective layer of silver or silver alloy applied over said transparent electrically conductive coating.

164. The exterior rearview mirror assembly as defined in claim 163, wherein said reflective electrode is partially transmissive and partially reflective with a reflectance of at least about 50 percent and a transmittance of at least about 10 percent in at least portions of the visible spectrum.



Prior Art

FIG. 1

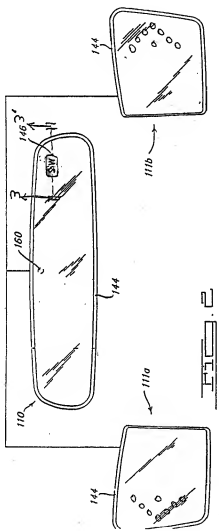


FIG. 2

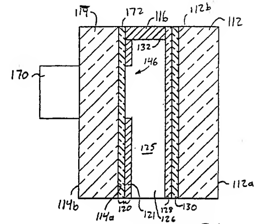


FIG. 3A

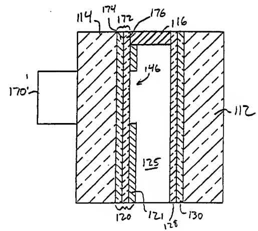


FIG. 3B

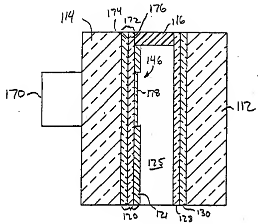


FIG. 3C

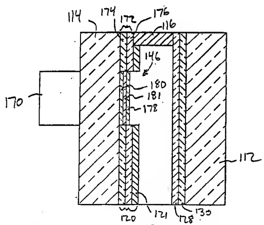


FIG. 3D

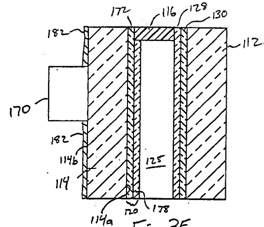


Fig. 3E

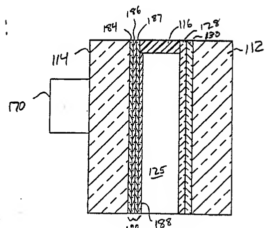


FIG. 3F

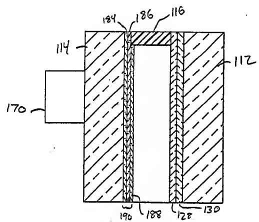
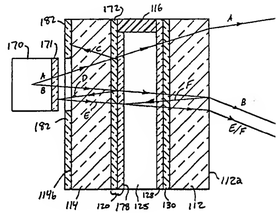


FIG. 3G

FIG. 4



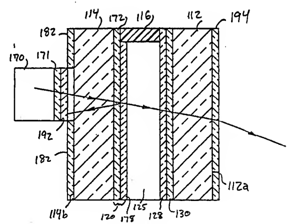
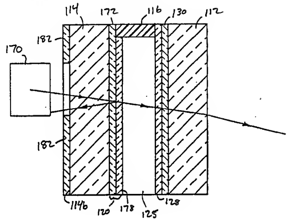


FIG. 5A

FIG. 5B



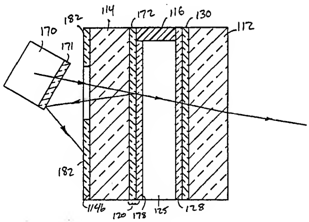
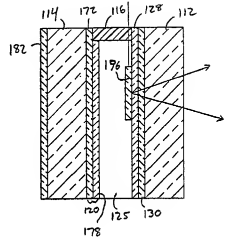


FIG. 5C

Fig. 5D



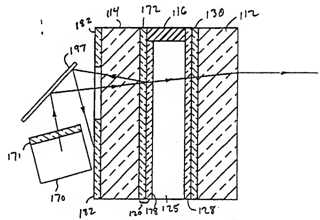


FIG. 5E

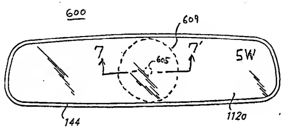


Fig. 6

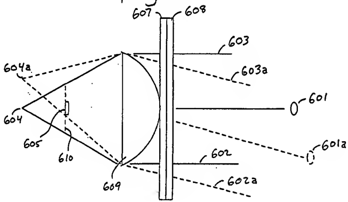


FIG.7

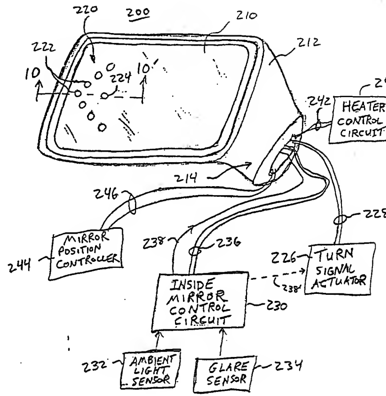


Fig. 8

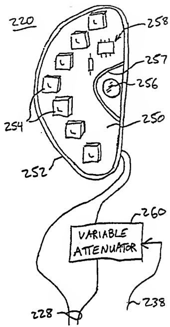


FIG. 9

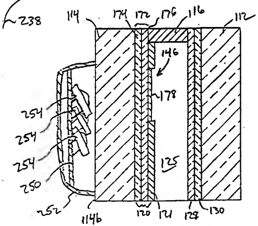


FIG. 10A

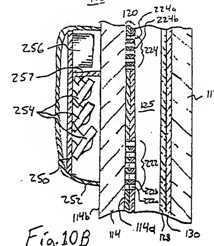


Fig. 10B

410 Fig. 10C

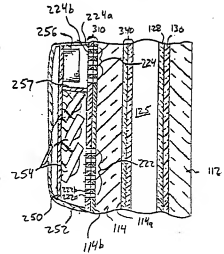
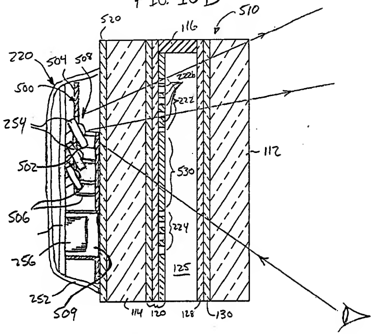


FIG. 10D



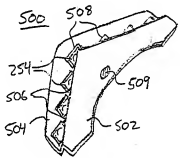


FIG. 15

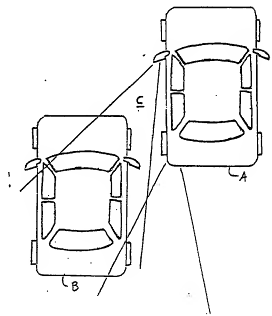


Fig. 11

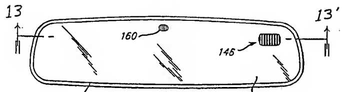


FIG. 12

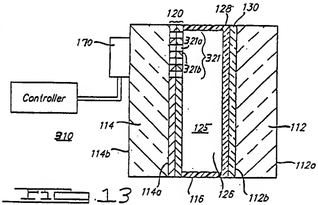


FIG. 13

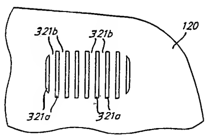
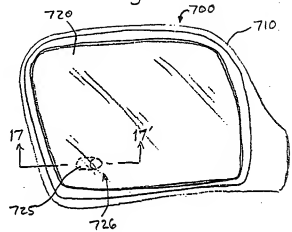


FIG. 14

Fig. 16



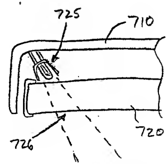


Fig.17

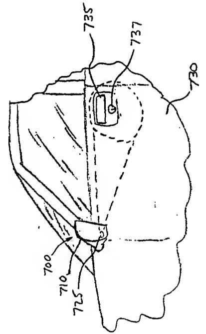


Fig. 18

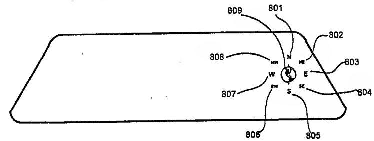


Fig. 19A

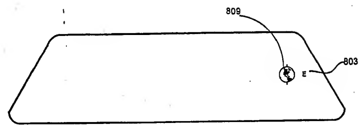


Fig. 19B

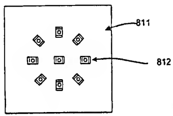


Fig. 20

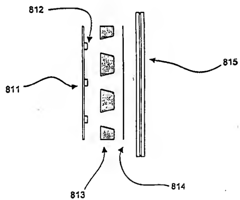


Fig. 21